Espacenet

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A METHOD AND A DEVICE FOR REDUCING HYSTERESIS OR IMPRINTING IN A MOVABLE MICRO-ELEMENT

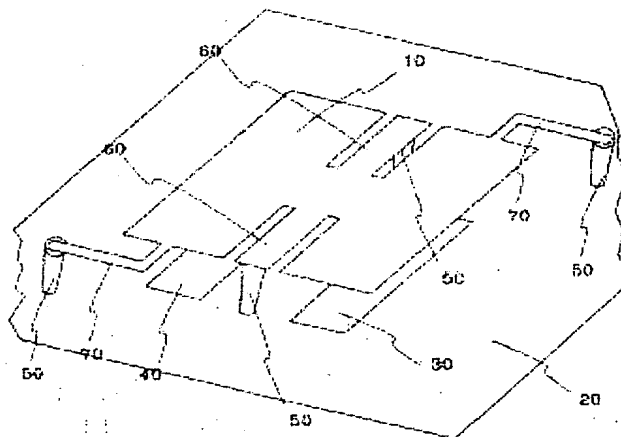|	
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Applicant(s):	
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The present invention relates to a movable micro element with reduced imprinting or hysteresis effect arranged spaced apart from a surface comprising at least one electrode. At least one restoring element is connected to said movable micro element. An address electrode is arranged on said surface and capable to electrostatically attract said movable micro element. Said address electrode is addressed to a first potential. Said movable micro element is first set to a second potential defining a non addressed state and at a time period [Delta]t before a predetermined pulsed signal is emitted said movable micro element is switched from said second potential to a third potential defining a addressed state. Said movable micro element is kept in said addresed state for a time period of [Delta]t+[Delta]t'. The invention also relates to a Spatial Light Modulator (SLM), an apparatus for patterning a workpiece and a method of reducing an imprinting or hysteresis effect of a movable micro element.

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CLAIMS

[Claim(s)]
[Claim 1]
Are estranged and arranged from the surface (20) which has at least one electrode, are movable microelement with little hysteresis (10), and to said movable microelement (10). In that by which at least one return component (60, 70) is connected, an address electrode (40) is allocated on said surface (20), electrostatic suction of said movable microelement (10) is possible, and the address of said address electrode (40) was carried out to the 1st potential,
In time deltat before a predetermined pulse signal is first sent to said movable microelement (10) to said movable microelement (10), Movable microelement (10), wherein it is set as the 2nd potential that forms a non-address state, said movable component is changed from said 2nd potential to the 3rd potential that forms an address state and said movable microelement (10) is maintained by said address state between time delta t+delta t'.
[Claim 2]
Movable microelement (10) which is the movable microelement (10) of Claim 1, and is returned to said non-address state after said address state when said movable microelement (10) returns said 3rd potential to said 2nd potential.
[Claim 3]
Movable microelement (10) from which it is the movable microelement (10) of Claim 1, and said movable microelement (10) is changed by electrostatic ********** after said 2nd potential state.
[Claim 4]
Are the movable microelement (10) of Claim 3 and said predetermined pulse signal, Movable microelement (10) which can clear said address electrode (40) and potential difference between said movable microelement (10), and returns said movable microelement (10) to said electrostatic ********** by this.
[Claim 5]
Movable microelement (10) which is Claim 1 or the movable microelement (10) of 4, and is the electromagnetic radiation by which said predetermined pulse signal is turned to said movable microelement (10).
[Claim 6]
Movable microelement (10) which is Claim 1 or the movable microelement (10) of 4, and is an electrical signal with possible making discharge of a capacitor by which loading is carried out in said 1st potential start while said predetermined pulse signal is connected to said address electrode (40).
[Claim 7]
It is one movable microelement of the Claims 1-6 (10), and said time delta t+delta t' is movable microelement shorter than 10 ms (10).
[Claim 8]
It is one movable microelement of the Claims 1-6 (10), and said time delta t+delta t' is movable microelement shorter than 10 microseconds (10).
[Claim 9]
Are the movable microelement (10) of Claim 1 and a value of said 2nd potential, . In both maximum potential and minimum potential by which an address is carried out to said address electrode (40), form non-deflection status. Movable microelement (10) in which it is substantially equal to a half of maximum potential by which an address is carried out to said address electrode (40), and said 3rd potential is substantially equal to said minimum potential by which an address is carried out to said address electrode (40).
[Claim 10]
Movable microelement (10) which is one movable microelement of the Claims 1-9 (10), and is supported by a twist hinge (60) of a couple with which said movable microelement (10) forms the axis-of-torsion heart along with the omitted portion.
[Claim 11]
Are one movable microelement of the Claims 1-9 (10), and said movable microelement (10), It is supported by member rotates (65) of a couple which forms the tiltable shaft heart along with the omitted portion, and said return component, Movable microelement (10) which is at least one crookedness hinge (70) which can permit that can come, simultaneously said movable microelement (10) tilts by a circumference of said tiltable shaft heart while returning said movable microelement (10) in non-deflection status.
[Claim 12]
Are the movable microelement (10) of Claim 10, and further, while returning said movable microelement in non-deflection status, Movable microelement (10) which has at least one crookedness hinge which can permit that can come, simultaneously said movable microelement (10) tilts by a circumference of said tiltable shaft heart or said axis-of-torsion heart.
[Claim 13]
Are one movable microelement of the Claims 1-9 (10), and said movable microelement (10), While returning said movable microelement (10) to a relaxed state along with one of omitted portions, Movable microelement (10) currently supported by a crookedness hinge (70) of a couple which can permit carrying out vertical migration to said surface (20) where it can come, simultaneously said movable microelement (10) has said at least one electrode.
[Claim 14]
Are one movable microelement of the Claims 1-9 (10), and said movable microelement (10), While returning said movable microelement (10) to a relaxed state along with two of the omitted portions, Movable microelement (10) currently supported by

two pairs of crookedness hinges (70) which can permit carrying out vertical migration to said surface (20) where it can come, simultaneously said movable microelement (10) has said at least one electrode.
[Claim 15]
Movable microelement (10) by which it is the movable microelement (10) of Claim 13 or either of 14, and said crookedness hinge (70) is attached to a corner of movable microelement (10) of polygonal shape.
[Claim 16]
Movable microelement (10) by which it is the movable microelement (10) of Claim 13 or either of 14, and an account crookedness hinge of beforehand (70) is attached to a surface part of movable microelement (10) of polygonal shape.
[Claim 17]
Movable microelement (10) whose at least one of the at least one and/or said axis-of-torsion hearts of said crookedness hinge (70) it is one movable microelement of the Claims 10-16 (10), and is winding form.
[Claim 18]
Are one movable microelement of the Claims 1-17 (10), and said surface (20), Having the counterelectrode (30) estranged from said address electrode (40) to the side, said address electrode (40) and said counterelectrode (30) are the movable microelement which can attract [electrostatic] said movable microelement (10) (10).
[Claim 19]
Movable microelement (10) which is the movable microelement (10) of Claim 18, and said predetermined pulse signal can clear [microelement] potential difference between said address electrode (40) and said counterelectrode (30), and returns said movable microelement (10) to said non-address state by this.
[Claim 20]
Movable microelement (10) which is the movable microelement (10) of Claim 18, and said predetermined pulse signal can clear [microelement] potential difference between said address electrode (40) and said counterelectrode (30), and returns said movable microelement (10) to electrostatic ********** by this.
[Claim 21]
Movable microelement (10) which is the movable microelement (10) of Claims 19-20, and is the electromagnetic radiation by which said predetermined pulse signal is turned to said movable microelement (10).
[Claim 22]
Movable microelement (10) which is the movable microelement (10) of Claims 19-20, and is an electrical signal which can discharge a capacitor by which loading is carried out in said 1st potential while said predetermined pulse signal is connected to said address electrode (40).
[Claim 23]
Movable microelement (10) to which it is Claim 1 or the movable microelement (10) of 19, and said predetermined pulse signal synchronizes with said time delta t+delta t' so that said time deltat' may become equal substantially with pulse length of said predetermined pulse signal.
[Claim 24]
A spatial-light-modulation machine, wherein it is a spatial-light-modulation machine provided with two or more reflecting members and said reflecting member is one movable microelement of the Claims 1-23 (10).
[Claim 25]
A spatial-light-modulation machine with which it is a spatial-light-modulation machine of Claim 24, and said reflecting member is set as one potential via one common element pin.
[Claim 26]
A spatial-light-modulation machine with which it is Claim 23 or a spatial-light-modulation machine of 24, and said counterelectrode (30) is set as one potential via one common opposite pin.
[Claim 27]
A spatial-light-modulation machine with which it is a spatial-light-modulation machine of Claims 23-26, and changes said all reflecting members substantially into the same time and an address state.
[Claim 28]
The following [it is equipment for patterning a work (60) which is arranged in an image formation face and induces electromagnetic radiation],
A source (11) which emits electromagnetic radiation towards an objective surface,
It has the computer control reticle (30) which received said electromagnetic radiation in said objective surface, and was constituted so that this electromagnetic radiation might be relayed towards said work (60) arranged in said image formation face and which has two or more reflective elements,
In that in which said computer control reticle (30) has two or more reflective elements here,
Equipment, wherein said reflective element is one movable microelement of the Claims 1-23.
[Claim 29]
In that in which it is a method for reducing hysteresis of movable microelement estranged and arranged from the surface, and said surface has at least one electrode here, said methods are the following processes. :
A process of setting said movable microelement as the 2nd potential that forms a non-address state,
It is the process of carrying out the address of the address electrode to the 1st potential, said address electrode is arranged on said surface here, and it is a process which can attract [electrostatic] said movable microelement,
A process changed from said 2nd potential to the 3rd potential that forms an address state in time deltat before said movable microelement is sent to a predetermined pulse signal,
A process of maintaining said movable microelement in said address state between time delta t+delta t'
How to include.
[Claim 30]
It is the method of Claim 29 and is a process of further the following. :
How to include a process returned to said non-address state by changing said movable microelement from said 3rd potential to said 2nd potential.
[Claim 31]
It is the method of Claim 29, and also they are the following processes. :
How to include a process of changing said movable microelement after said address state at electrostatic **********.

[Claim 32]
It is the method of Claim 31, and also they are the following processes. :
How to include a process which clears potential difference between said address electrode and said movable micro mirror, and returns said movable microelement to said electrostatic ********** by this with said predetermined pulse signal.
[Claim 33]
A way it is one method of the Claims 29-32, and said predetermined pulse signal is an electromagnetic radiation signal turned to said movable microelement.
[Claim 34]
How to be one method of the Claims 29-32, and be an electrical signal with possible making discharge of a capacitor by which loading is carried out in said 1st potential start, while said predetermined pulse signal is connected to said address electrode.
[Claim 35]
It is one method of the Claims 29-34, and said time delta t+delta t' is a method shorter than 10 ms.
[Claim 36]
It is one method of the Claims 29-34, and said time delta t+delta t' is a method shorter than 10 microseconds.
[Claim 37]
Are one method of the Claims 29-36, and a value of said 2nd potential, . In both maximum potential and minimum potential by which an address is carried out to said address electrode, form non-deflection status. A method that it is substantially equal to a half of maximum potential by which an address is carried out to said address electrode, and said 3rd potential is substantially equal to said minimum potential by which an address is carried out to said address electrode.
[Claim 38]
It is one method of the Claims 29-37, and also they are the following processes. :
How to include a process of supporting said movable microelement along with the omitted portion with a twist hinge of a couple which forms the axis-of-torsion heart.
[Claim 39]
It is one method of the Claims 29-37, and also they are the following processes. :
Along with the omitted portion, are a process supported by a member rotates of a couple which forms the tiltable shaft heart, and here said movable microelement said return component, How to include a process which is at least one crookedness hinge which can permit that can come, simultaneously said movable microelement tilts by a circumference of said tiltable shaft heart while returning said movable microelement in non-deflection status.
[Claim 40]
It is one method of the Claims 38-39, and is a process of further the following. :
How to include a process to which said movable microelement is returned with at least one crookedness hinge.
[Claim 41]
It is one method of the Claims 29-37, and is a process of further the following. :
While returning said movable microelement to a relaxed state along with one of omitted portions, said movable microelement, How to include a process supported with a crookedness hinge of a couple which can permit carrying out vertical migration to said surface where it can come, simultaneously said movable microelement has said at least one electrode.
[Claim 42]
It is one method of the Claims 29-37, and is a process of further the following. :
While returning said movable microelement to a relaxed state along with two of the omitted portions, said movable microelement, How to include a process supported with a crookedness hinge of a couple which can permit carrying out vertical migration to said surface where it can come, simultaneously said movable microelement has said at least one electrode.
[Claim 43]
A method by which it is one method of the Claims 41-42, and said crookedness hinge is attached to a polygonal corner.
[Claim 44]
A method by which it is one method of the Claims 41-42, and said crookedness hinge is attached to a polygonal surface part.
[Claim 45]
A way it is one method of the Claims 38-44, and at least one of the at least one and/or said axis-of-torsion hearts of said crookedness hinge is winding form.
[Claim 46]
A way it is one method of the Claims 29-45, and said movable microelement is one movable microelement of the Claims 1-23.
[Claim 47]
It is one method of the Claims 29-46, and is a process of further the following. :
How to include a process which synchronizes said predetermined pulse signal with said time delta t+delta t' so that said time deltat' may become equal substantially with pulse length of said given signal.
[Claim 48]
It is the method of Claim 29 and is a process of further the following. :
How to include a process of neutralization-izing an accumulation history operation while preventing said pulse signal reaching said movable microelement.
[Claim 49]
A method which is the method of Claim 48, and is performed when a neutralization chemically-modified [said] degree makes an opposite direction deflect movable microelement of these each to the state of deviating during an operation by which said movable microelement was meant.
[Claim 50]
A method which is the method of Claim 49 and is deflected in given time and a given deflection degree, and the 1st direction . according to a degree of a deviation [in / in each movable microelement / said accumulated time and the 2nd deflection direction].
[Claim 51]
A method performed between different strips from which it is the method of Claim 48 and said neutralization-ization of said accumulation history operation constitutes a perfect pattern on a work.
[Claim 52]
A method by which it is the method of Claim 48, and said neutralization-ization of said accumulation history operation is

performed after the accumulated time deviation of predetermined is carried out for at least one movable microelement.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[Field of the Invention]
[0001]
This invention relates to the technology for generally decreasing the hysteresis or hysteresis in a machine member, and movable microelement and the method of carrying out an address to it especially.
[Background of the Invention]
[0002]
The hysteresis or history of mirror deflection quantity in the spatial-light-modulation machine (SLM) used as the cause of changing address voltage required for a suitable mirror deviation is a problem in order for the accuracy of a deviation of a mirror to fall by it. The time, the deflection quantity, and the mirror by which that mirror was deflected depend for this change on the time which needs to loosen after that deviation. Since the ranges of the damping time constant of these phenomena are several minute room/several hours, required address voltage is predicted in a mask writer or the arbitrary patterns in the direct writer which uses the newest SLM technology, and it cannot compensate it as a matter of fact.
[0003]
The problem in compensating a history is on data being loaded to the mirror of SLM from the always same direction for every line. When this has all the mirrors in perfect deflection status, it means that the pixel of the 1st row has a very high duty cycle, and they have a very low duty cycle and it has a middle duty cycle in a middle line in the last line. Therefore, unless SLM is reconstructed so that data may be loaded from the 1st line and the last line for every two-times eye in order to equalize these duty cycles, as balance to hysteresis, also using collectively the pixel counter electrode in which an address is possible -- an impossibility -- or it is dramatically difficult at least. Even when constituted such, a history is still pattern dependence. Probably, it will be required to neglect predetermined time and its system to an idle state, in order to proofread a mirror frequently or to loosen the mirror of SLM.

[0004]
Therefore, little method and equipment of hysteresis are called for in the field concerned.
[Description of the Invention]
[Problem to be solved by the invention]
[0005]
In the method for carrying out an address to movable microelement and each movable microelement, such as a mirror member of SLM, in view of the above-mentioned background, it is dramatically important to decrease hysteresis.
[0006]
Therefore, there is SUBJECT of this invention in providing the improved movable microelement which solves the problem mentioned above or is reduced at least.
[Means for solving problem]
[0007]
In the 1st embodiment, this invention is estranged and arranged from the surface which has at least one electrode, and movable microelement with few hysteresis or hysteresis effects is provided. At least one return component is connected to said movable microelement. An address electrode is allocated on said surface and electrostatic suction of said movable microelement is possible. The address of said address electrode is carried out to the 1st potential. Said movable microelement is first set as the 2nd potential that forms a non-address state, and said movable microelement is changed from said 2nd potential to the 3rd potential that forms an address state in time deltat before a predetermined pulse signal is sent. Said movable microelement is maintained by said address state between time delta t+delta t'.
[0008]
In another embodiment of this invention, said movable microelement is returned to said non-address state after said address state by returning said 3rd potential to said 2nd potential.
[0009]
In another embodiment of this invention, said movable microelement is changed by electrostatic ********** after said address state.
[0010]
In another embodiment of this invention, said predetermined pulse signal can clear the potential difference between said address electrode and said movable microelement, and, thereby, returns said movable microelement to said electrostatic **********.
[0011]
In another embodiment of this invention, said given signal is an electromagnetic radiation signal turned to said movable microelement.
[0012]
In another embodiment of this invention, said given signal is an electrical signal with possible making the discharge of a capacitor by which loading is carried out in said 1st potential start while being connected to said address electrode.
[0013]
In another embodiment of this invention, said time delta t+delta t' is shorter than 10 ms.

[0014]
In another embodiment of this invention, said time delta t+delta t' is shorter than 10 microseconds.
[0015]
In another embodiment of this invention, the value of said 2nd potential, It is substantially equal to the half of the maximum potential by which an address is carried out to said address electrode which forms non-deflection status in both the maximum potential and minimum potential by which an address is carried out to said address electrode, and said 3rd potential is substantially equal to said minimum potential by which an address is carried out to said address electrode.
[0016]
In another embodiment of this invention, said movable microelement is supported along with the omitted portion by the twist hinge of the couple which forms the axis-of-torsion heart.
[0017]
In another embodiment of this invention, said movable microelement, It is supported by the member rotates of the couple which forms the tiltable shaft heart along with the omitted portion, and said return component, While returning said movable microelement in non-deflection status, it is at least one crookedness hinge which can permit that can come, simultaneously said movable microelement tilts by the circumference of said tiltable shaft heart.
[0018]
In another embodiment, further, this invention has at least one crookedness hinge which can permit that can come, simultaneously said movable microelement rotates by the circumference of said tiltable shaft heart while returning said movable microelement in non-deflecting positions.
[0019]
In another embodiment of this invention, said movable microelement, While returning said movable microelement to a relaxed state along with one of omitted portions, it is supported by the crookedness hinge of the couple which can permit carrying out vertical migration to said surface where it can come, simultaneously said movable microelement has said at least one electrode.
[0020]
In another embodiment of this invention, said movable microelement, While returning said movable microelement to a relaxed state along with two of the omitted portions, it is supported by two pairs of crookedness hinges which can permit carrying out vertical migration to said surface where it can come, simultaneously said movable microelement has said at least one electrode.
[0021]
Said crookedness hinge is attached to the polygonal corner in another embodiment of this invention.
[0022]
Said crookedness hinge is attached to the polygonal surface part in another embodiment of this invention.
[0023]
In another embodiment of this invention, at least one of the at least one and/or said axis-of-torsion hearts of said crookedness hinge is winding form.
[0024]
In another embodiment of this invention, said surface has further the counterelectrode estranged from said address electrode to the side, and electrostatic suction of said movable microelement is possible for said address electrode and said counterelectrode.

[0025]
In another embodiment of this invention, said predetermined pulse signal can clear the potential difference between said address electrode and said counterelectrode, and returns said movable microelement to said non-address state by this.
[0026]
In another embodiment of this invention, said predetermined pulse signal can clear the potential difference between said address electrode and said counterelectrode, and returns said movable microelement to electrostatic ********** by this.
[0027]
In another embodiment of this invention, said given signal is electromagnetic radiation turned to said movable microelement.
[0028]
Said given signal is [in / further / another embodiment] an electrical signal which can discharge the capacitor of this invention by which loading is carried out in said 1st potential while being connected to said address electrode.
[0029]
In another embodiment of this invention, said predetermined pulse signal synchronizes with said time delta t+delta t' so that said time deltat' may become equal substantially with the pulse length of said given signal.
[0030]
Said reflecting member is one movable microelement of said embodiments here about a spatial-light-modulation machine provided with the reflecting member of further plurality [this invention].
[0031]
In another embodiment of this invention, said reflecting member is set as one potential via one common element pin.
[0032]
In another embodiment of this invention, said counterelectrode is set as one potential via one common opposite pin.
[0033]
In another embodiment of this invention, it changes said all reflecting members substantially into the same time and an address state.
[0034]
Further, this invention is arranged in an image formation face, and relates to the equipment for patterning the work which induces electromagnetic radiation.
[0035]
The source in which this invention emits electromagnetic radiation towards an objective surface in the 1st embodiment, Provide the computer control reticle which received said electromagnetic radiation in said objective surface, and was constituted so that this electromagnetic radiation might be relayed towards said work arranged in said objective surface and which has two or more reflective movable microelement, and here, In that in which said computer control reticle has two or more reflective micro components, said reflective micro component is characterized by being one movable microelement of said embodiments.
[0036]

Said surface has at least one electrode here about a method for this invention to reduce further the hysteresis of the movable microelement estranged and arranged from the surface.
[0037]
In the 1st embodiment, this invention includes the following processes,
Said movable microelement is set as the 2nd potential that forms a non-address state.
An address electrode is arranged on said surface and electrostatic suction of said movable microelement is possible for it here where the address of the address electrode is carried out to the 1st potential,
In time deltat before said movable microelement is sent to a predetermined pulse signal, it changes from said 3rd potential to the 4th potential that forms an address state,
Said movable microelement is maintained in said address state between time delta t+delta t'.
[0038]
In another embodiment, this invention includes the following processes further,
By changing said movable microelement from said 3rd potential to said 2nd potential, it returns to said non-address state.
[0039]
In another embodiment, this invention includes the following processes further,
Said movable microelement is changed after said address state at electrostatic **********.
[0040]
In another embodiment, this invention includes the following processes further,
With said predetermined pulse signal, the potential difference between said address electrode and said movable microelement is cleared, and, thereby, said movable microelement is returned to said electrostatic **********.
[0041]
In another embodiment of this invention, said given signal is an electromagnetic radiation signal turned to said movable microelement.
[0042]
In another embodiment of this invention, said given signal is an electrical signal with possible making the discharge of a capacitor by which loading is carried out in said 1st potential start while being connected to said address electrode.
[0043]
In another embodiment of this invention, said time delta t+delta t' is shorter than 10 ms.
[0044]
In another embodiment of this invention, said time delta t+delta t' is shorter than 10 microseconds.
[0045]
In another embodiment of this invention, said 2nd potential, It is substantially equal to the half of the maximum potential by which an address is carried out to said address electrode which forms non-deflection status in both the maximum potential and minimum potential by which an address is carried out to said address electrode, and said 3rd potential is substantially equal to said minimum potential by which an address is carried out to said address electrode.
[0046]
In another embodiment, this invention includes the following processes further,
Said movable microelement is supported along with the omitted portion with the twist hinge of the couple which forms the axis-of-torsion heart.
[0047]
In another embodiment, this invention includes the following processes further,
Along with the omitted portion, said movable microelement here where it supports by the member rotates of the couple which forms the tiltable shaft heart said return component, While returning said movable microelement in non-deflection status, it is at least one crookedness hinge which can permit that can come, simultaneously said movable microelement rotates by the circumference of said tiltable shaft heart.
[0048]
In another embodiment, this invention includes the process of further the following,
Said movable microelement is returned with at least one crookedness hinge.
[0049]
In another embodiment, this invention includes the following processes further,
While returning said movable microelement to a relaxed state along with one of omitted portions, said movable microelement, It supports with the crookedness hinge of the couple which can permit carrying out vertical migration to said surface where it can come, simultaneously said movable microelement has said at least one electrode.
[0050]
In another embodiment, this invention includes the following processes further,
While returning said movable microelement to a relaxed state along with two of the omitted portions, said movable microelement, It supports with the crookedness hinge of the couple which can permit carrying out vertical migration to said surface where it can come, simultaneously said movable microelement has said at least one electrode.
[0051]
Said crookedness hinge is attached to the polygonal corner in another embodiment of this invention.
[0052]
Said crookedness hinge is attached to the polygonal surface part in another embodiment of this invention.
[0053]
In another embodiment, this invention includes the following processes further,
At least one of the at least one and/or said axis-of-torsion hearts of said crookedness hinge is winding form.
[0054]
In another embodiment of this invention, said movable microelement is one movable microelement of said embodiments.
[0055]
In another embodiment, this invention includes the following processes further,
Said time deltat' synchronizes said predetermined pulse signal with said time delta t+delta t' so that it may become equal substantially with the pulse length of said given signal.
[Best Mode of Carrying Out the Invention]

[0056]

For a still more perfect understanding of this invention and its advantage, the following explanation is referred to with reference to an accompanying drawing.

[0057]

Drawing 1 a is illustrating the 1st embodiment of movable microelement, for example, micro machine member, ** with little hysteresis by this invention. Said movable microelement can be used as the mirror of a spatial-light-modulation machine (Spatial Light Modulator:SLM), for example. Said mirror can operate in the digital mode in which ON and the OFF state of this mirror member which are analog modes in order to operate the deflection degree of this mirror member selectively as a function of an electrical input, or are formed of a maximum deflection and un-deviating are expressed. According to how it acts physically, as a function of said input signal, this mirror (movable microelement) may be linearity mostly, and the deviation of said mirror member may have it. [nonlinear]

[0058]

in this example, said movable microelement 10 was supported by the twist hinge 60 of the couple along with the one omitted portion — it is a rectangular reflecting member mostly. This reflecting member can be made into arbitrary form, such as a polygon, circular, or an ellipse form, for example. Said hinge is twisted along with it and forms an axial center. Said twist hinge extends from said movable microelement 10, and is supported by the support component 50. This support component is supported on the base material 20. Said movable microelement 10, said twist hinge 60, said support component 50, and said base material, For example, since it can form from the same materials, such as silicon and aluminum, and they can be etched from one base material for a person skilled in the art using well-known etching technology, it is unnecessary to explain them further.

[0059]

Said base material is provided with the following.

The conductive address electrode 40.

The conductive counterelectrode 30 as an option.

These address electrodes 40 and the counterelectrode 30 as an option are connected to the address circuit (not shown) of the lower part formed in said base material 20. Said address electrode is connected to a capacitor and these capacitors hold the address voltage by which an address is carried out to said electrode. The counterelectrode 30 and the address electrode 40 of said option are mutually estranged on said surface 20 in the side, and electrostatic suction of said movable microelement 10 is possible for them. Said twist hinge 60 is rotated or twisted with said movable microelement 10, and provides the stability as mechanical energy. When voltage is not built to the counterelectrode 30 and address electrode of said movable microelement and said option, in the following explanation, it is supposed that it is said movable micro component in the ****** deflecting positions which are indicated as an electric non-suction state and which are the usual flats. A counter direction can be made to rotate said movable microelement by shifting said address voltage from an address electrode to a counterelectrode.

[0060]

Drawing 1 b is illustrating the 2nd embodiment of movable microelement with little hysteresis by this invention. This 2nd embodiment has the two flexible hinges 70 supported by the support component 50 while being connected to said movable microelement 10 in addition to said 1st embodiment. When said movable microelement 10 deviates by the circumference of said twist axial center formed by said twist hinge 60, these flexible hinges 70 also provide stability, and are changed or crooked. In this embodiment, said flexible hinge 70 is L form in which one of ends was connected to said support component 50, and that other end was connected to said movable microelement 10. One side of these flexible hinges was connected to the same side as one side of said twist hinge, the flexible hinge of another side was connected to the same side as the twist hinge of another side, and these flexible hinges are mutually estranged to the diagonal direction on said movable microelement.

[0061]

Drawing 1 c is illustrating the 3rd embodiment of movable microelement with little hysteresis by this invention. The point of difference of this embodiment and said 2nd embodiment has said movable microelement 10 in having the two pivotal support parts 65 instead of the aforementioned torsion hinge 60. These pivotal support parts are supported by said support component 50. These pivotal support parts are located in the crevice 55 formed in the upper part of said support component 50, only the tilt in the circumference of the tiltable shaft heart of said movable microelement 20 is permitted, and that it separates and moves to the side from the position conforms to the size of said pivotal support part 65 so that it may not approve.

[0062]

Stability is provided by the flexible hinge 70 changed or crooked when said movable microelement 10 deviates by the circumference of said tiltable shaft heart formed of said pivotal support part 60. In this embodiment, said flexible hinge 70 is L form in which one of ends was connected to said support component 50, and that other end was connected to said movable microelement 10. One side of these flexible hinges was connected to the same side as one side of said pivotal support part, the flexible hinge of another side was connected to the same side as the pivotal support part of another side, and these flexible hinges are mutually estranged to the diagonal direction on said movable microelement.

[0063]

Drawing 1 d is illustrating the 4th embodiment of movable microelement with little hysteresis by this invention. There is a point of difference with the above-mentioned embodiment indicated with reference to this 4th embodiment and drawing 1-3 in the movable microelement 10 carrying out vertical movement in the vertical direction to the surface 20 to which at least one address electrode 40 was attached. The flexible hinge 70 is supported by the support component 50 while being connected to said movable microelement 10. Said flexible hinge 70 is changed or crooked, when stability is provided and said movable microelement 10 carries out vertical movement perpendicularly substantially to said surface 20. In this embodiment, said flexible hinge 70 is the rectangular shape with which one of ends was connected to said support component 50, and that another end was connected to said movable microelement 10. Said flexible hinge is attached to the 2 opposed faces of the movable microelement 10 of said rectangle. Preferably, said hinge is in agreement with one of the symmetrical axial centers of said movable microelement 10. In another embodiment, at least, the flexible hinge 70 of a couple is attached to said movable microelement 10, and these already corresponds with another axis of symmetry of this movable microelement 10. In the embodiment of drawing 1 d, although said address electrode 40 is the same form in the same size as substantially as said movable microelement 10, it is also possible to both differ the form and size of this address electrode from said movable microelement 10. Said address electrode can also be divided into two or more address electrodes 40 again. Other movable microelement (the same pixel) in the state where it maintained to the slackened position (The state which does not have an electrostatic suction force between the movable microelement 10 and the address electrode 40), Destructive interference is attained by what the movable microelement 10 is

caudad shifted for (one fourth of the wavelength used in order to hit this component).
[0064]
Drawing 1 e is illustrating the 5th embodiment of movable microelement with little hysteresis by this invention. Said flexible hinge 70 is L form, the number of these flexible members 70 is not 2 but 4, and the point of difference of this 5th embodiment and said 4th embodiment has it in those each sets being substantially in agreement with a diagonal symmetrical axial center further.
[0065]
Drawing 2 shows the abbreviated flow chart of the method of reducing hysteresis by this invention.
[0066]
The 1st process 110 expresses the process of setting said movable microelement 10 as the 2nd potential. Said 2nd potential can be made into the potential which is a half of the value of the maximum potential by which an address is carried out to said address electrode, for example. Said 3rd electrode forms a non-address state.
[0067]
The 2nd process 120 expresses the process of carrying out the address of the address electrode 40 to the 1st potential. Said 1st potential can be made into the any value between minimum potential and said maximum potential, said minimum potential can be made into earth potentials, and said maximum potential can be set to 20V here. Said address electrode 40 is arranged on said surface 20, and electrostatic suction of said movable microelement 10 is possible for it.
[0068]
The 3rd process 130 expresses the process of changing said movable microelement from said 2nd potential to the 3rd potential that forms an address state. The change to this 3rd potential is performed to time deltat before a predetermined pulse signal is sent. Said 3rd potential can be made into earth potentials, for example.
[0069]
The 4th process 140 is shorter than 10 ms, and expresses the process of maintaining said movable microelement by another embodiment in the one embodiment in time equal to delta t+delta t' shorter than 10 microseconds, and said address state. deltat' should correspond to the time for discharging a capacitor made into several microseconds or less than it according to the type and size of the capacitor, for example. deltat -- the any value of the range of a sub second -- it can be most preferably set as the value for 10 or less microseconds about 10 or less ms. Although deltat is longer than deltat', it can also usually apply the opposite composition. Said given signal can be used as pulse electromagnetic radiation beams, such as a pulse laser, for example. deltat' synchronizes with the pulse length of said pulse signal in one embodiment.
[0070]
After changing into said time delta t+delta t' aforementioned address state, said movable microelement is returned to said 2nd potential, or is changed to electrostatic **********.
[0071]
A spatial-light-modulation machine can be provided with two or more mirrors which can be considered as the type of the movable microelement arranged at a one-dimensional sequence or two-dimensional array form. In said SLM, it can connect with one voltage plane and all the movable microelement, i.e., mirror surfaces, can carry out an address to this flat surface in one of the input pins, and what is called an element pin. The same thing is applied also to all the counterelectrodes 30 on said base material 20. Namely, an address is possible for both them using what is called an opposite pin. When said counterelectrode 30 is maintained by earth potentials, said address electrode, An address is carried out to earth potentials, movable microelement is set as either of said 3rd or 4th potential, and since the potential difference between an address electrode and movable microelement is equal to the potential difference between a counterelectrode and movable microelement, movable microelement is not deflected. However, it is also possible to provide the bending part to a small lower part among both the edge of movable microelement depending on the thickness. This bending part sets the thickness of said movable microelement constant, and increases with the increase in the voltage concerning this movable microelement. All the mirrors of said SLM are substantially changed from said 3rd potential from said non-address state simultaneously to said 4th potential, i.e., said address state. all the mirrors of SLM -- moreover -- it is in said address state the same time (deltat+deltat') substantially -- this -- the hysteresis of these mirror members -- removal -- or it decreases at least. These mirror members have so few degrees influenced by a hysteresis effect (hysteresis) that the time when these mirror members are in an address state is short. That is, the influence on the mirror member by said hysteresis effect decreases, so that the duty cycle which the time when a mirror member is in an address state carries out comparatively, and is defined is short. A mirror member not only stops at said address state short time, but in the same time, i.e., deltat+deltat', all mirror members stop at said address state substantially.
[0072]
If movable microelement is set as 10V and a counterelectrode is maintained by earth potentials, in both cases where an address is carried out to the case where the address of the address electrode is carried out to the minimum voltage 0V, and the maximum voltage 20V, the movable microelement 10 will stop at non-deflection status substantially. This is not important for the mark of voltage in electrostatic force, and he can understand it by recognizing that it is always a suction state. An example of the deviation as a function of the potential difference between an address electrode and movable microelement is illustrated by drawing 3. In drawing 3, a movable component is in zero potential, and the potential of the address electrode is changing, moving a deflection degree up and down by turns, and measuring it. In this figure, the movable microelement can understand that it is non-deflection status substantially below by a certain potential difference (this example 10V). The electromagnetic force between movable microelement and an address electrode receives reaction according to the mechanical stability of said twist hinge 60 (singular number or plurality) and/or the flexible hinge 70. According to the type and number of these twist hinge and/or flexible hinges which were attached to movable microelement, said deviation as a function of the potential difference between an address electrode and movable microelement can change.
[0073]
This means that it is possible to carry out an address to all the pixels (namely, rotation member), without deflecting substantially the rotation member which corresponds to a rotation member using 10V. For example, if the voltage to movable microelement shifts to 0 volt just before said electromagnetic radiation signal turned to said movable microelement, and the predetermined signal which can be carried out, all the movable microelement will be in said request deflection status simultaneously. If said electromagnetic radiation is equivalent to movable microelement, all the capacitors connected to said address electrode on a base material will be discharged, and movable microelement will return to said un-deviating and an electromagnetism non-suction state immediately. Thus, the duty cycle which deflects all the movable microelement is maintainable as a very small thing based on the switching time of miller voltage. If delta t+delta t' is maintained at 10 microseconds, supposing the frequency of said pulse

signal will be 1000 Hz, the duty cycle of perfect deflection status will be 1%.
[0074]
When the address of said address electrode is carried out to said maximum or the minimum (grounding) potential, movable microelement is set as the half of the value of maximum potential and a counterelectrode is maintained by earth potentials, the address of the movable microelement is not deflected and carried out. In the case of each value between maximum potential and minimum potential, the address of the movable microelement is not deflected and carried out. The worst case is a case where address voltage is a half of the value of the maximum. In this case, since both an address electrode and movable microelement are 10V, power is not generated among them. Next, a counterelectrode pulls movable microelement caudad with the power corresponding to 10V. However, to a fortunate thing, this deviation is comparatively small by the nonlinear action of movable microelement so that I may be understood from drawing 3.
[0075]
Drawing 4 is illustrating the embodiment of the equipment 100 for patterning the work 60 coated by the layer of electromagnetic radiation induction material. This equipment 100 is provided with the following.
The source 11 which emits electromagnetic radiation.
The 1st lens system 50.   .
Computer control reticle 30.
The 2nd lens system 20, the spatial filter 70, the 3rd lens system 40, and the work 60.

[0076]
In this application from the infrared rays (IR) which carry out said source 11 to from 780 nm to about 20 micrometers, and are defined, The radiation of the wavelength range to the extreme ultraviolet rays (EUV) defined from 100 nm as a range of all possible [that the radiation is treated as electromagnetic radiation] low wavelength can be emitted. This source 11 emits radiation to pulse form or continuous state. The discharge radiation from the continuous radiation line source 11 can be formed in pulse form radiation with the shutter located in the radiation course between this radiation source 11 and said computer control reticle 30. Said radiation source 11 can be made into a 1000 Hz [in 248 nm of pulse outputs, about 10 ns of pulse length, and repetitive speed] KrF excimer laser as an example. Said repetitive speed may be 1000 Hz or less, and may be not less than 1000 Hz. Said 2nd lens system 20 can be made into the assembly of a simple lens or two or more lenses. This 2nd lens system 20 distributes uniformly the radiation emitted from said radiation source 11 on the surface of said computer control reticle 30.
[0077]
Said 2nd lens system 20 can have the exit pupil in infinite distance, and means that this has the parallel center shaft heart of the cone of radiation. The center shaft heart of said radiation cone of said objective surface is [in / in accordance with the position of said computer control reticle 30 / at this embodiment / said objective surface] parallel. Said computer control reticle 30 can be used as a spatial-light-modulation machine (SLM). In this embodiment, this SLM has all the information required to pattern said work 60 whole at a single moment.
[0078]
The spatial-light-modulation machine 30 can be made into a reflection type or a transmission type thing. In the embodiment illustrated by drawing 1, said SLM is the reflection type SLM. Reflection type spatial-light-modulation machines are two types, i.e., a deviation type and a phase type, and ******. In the case of a micro mirror, especially the difference between these may be visible to a small thing, but the phase type SLM, The pixel of the deviation type SLM makes one side deflect a reflective beam geometrically to erasing the beam of a reflecting direction by destructive interference, so that a reflective beam may separate from the caliber of an image formation lens. Usually, the micro mirror of the deviation type SLM is more greatly displaced as compared with the micro mirror of the phase type SLM from the flat position formed of the surface of loose SLM whose surface of a micro mirror is a flat. For ultraprecise patterning which is performed by this invention, the phase type SLM is superior to the deviation type SLM.
[0079]
Since it is possible all the parts of the surface and for a hinge and a supporting post to participate in said destructive interference, and to attain perfect extinction further as for the phase type SLM, contrast is more excellent in the 1st.
[0080]
The system which acts by 2nd deflecting radiation in one side is difficult to form symmetrically by the circumference of an optic axis in a middle change angle, and when a focus is changed, there is a possibility that functional instability may occur. The phase type SLM can be built according to a micro processing mirror, what is called a micro mirror, or the continuation mirror surface on a supporting substrate, and said mirror surface can be changed using an electrical signal.
[0081]
For example, although the viscoelasticity layer controlled by electrostatic electric field can be used for said continuation mirror, It comes out enough especially by modification of about several nanometers, and, in the case of a certain very short wavelength, it is possible similarly that electric field or others are electric and to use the piezo-electric solid disk transformed by the reflector controlled magnetically or thermally. In the description of the following of this application, although premised on the electrostatic control micro mirror matrix (one dimension or two dimensions), Other composition which was mentioned above, such as micro mechanical SLM which uses the transmission type or the reflection type SLM based on a LCD crystal or electrooptic material, a piezo-electric formula, or electrostriction operation as those abnormal-conditions mechanisms, is also possible.
[0082]
Said SLM is programmable equipment which generates the output radiation modulated by the separate input from a computer. SLM answers the data supplied from a computer and simulates an operation of a mask through generating of luminosity or a dark pixel. For example, the phase type SLM is an array of the etched solid mirror. Each micro mirror component is hung above the silicon base material by the twist hinge which another supporting post or an adjoining mirror is not, but can be supported by **. The address electrode is arranged under these micro mirror components. One micro mirror expresses one pixel to an objective surface. The sizes should differ by whether to be large according to the optical system, i.e., is [whether the optical system is an expansion type and] it a non-expanding formula?, although the pixel of an image formation face is defined as what has the same geometrical form as a micro mirror here, or small.
[0083]
Said micro mirror and an address electrode act as a capacitor, and to the voltage to a micro mirror with the voltage applied to an

address electrode. Said twist hinge which has hung the micro mirror is twisted, it permits that a micro mirror rotates by this, and phase contrast is made by it. According to the voltage given, any state from a flat position to a perfect rotary place can take rotation of a micro mirror. The micro mirrors of the perfect rolling state whose length of the neighborhood is about 16 micrometers and which has the rectangular surface substantially are usually 8mRad. More generally said full rotation micro mirror, 1/4 of the wavelength which is measurement with parallel edge and is used to a shaft center -- rotating -- or -- or in the case of the micro mirror which moves vertically to said surface, the difference between the maximum state and the minimum state is 1/4 of the wavelength which is parallel measurement and is used to the surface of said micro mirror.
[0084]
The projection system 80 is provided with the following.
In this embodiment, it is said 3rd lens system 40.
Spatial filter 70.
Said 1st lens system 50.
Said 3rd lens system 40 and the spatial filter 70 are collaboration, and what is generally called the Fourier filter is formed.
[0085]
Said spatial filter 70 is the hole formed in the plate in this embodiment. this hole is diffracted by the primary and higher order degree -- all the orders of diffraction are prevented substantially -- as -- size composition -- and the arrangement configuration is carried out, for example, said hole can be arranged from said 3rd lens system 40 to a focal distance position. In the focal plane which acts also as a pupil side of said 1st lens system 50 simultaneously, the reflected radiation is collected by the 3rd lens system 40. Said hole can carry out the cutout of the light of the primary or higher order order of diffraction of the micro mirror in SLM by which the address was carried out, on the other hand the radiation from the non-address mirror surface can pass through this hole. As a result, the space image by which intensity modulation was carried out on the work 60 is formed like the conventional lithography. For the optimal picture contrast, the diffraction pattern of SLM by which all the pixels were changed should contain only the light of primary and the order of diffraction higher order than it without the radiation of zeroth order.
[0086]
Said 1st lens system 50 has that exit pupil on the infinite edge in this embodiment. That is, the medial-axis heart of the cone of the radiation of the image formation face formed of the position of the work 60 is parallel.
[0087]
Said work 60 can be used as the base material provided with sensitization sides, such as a semiconductor device and a photo mask for display panels. It can also be considered as the semiconductor wafer coated by the photosensitive layer again. Since this invention does not have a use directly only in patterning of semiconductor device Bataan, a display panel, integral-type Optical Devices Division, and electronic interconnection structure, it is available also to patterning of the type of others, such as security patterning. Here the term of patterning only not only in exposure of photoresist and a photographic emulsion, I should be understood by the large meaning also meaning an operation of the radiation to other radiation induction media (for example, dry process paper) started with radiation or heat, such as ablation or a chemical process. The processed wafer of this invention is available again also to the wafer restoration reworked by radiation.
[0088]
Said work 60 can also be arranged on the moving stage where it moves at a fixed speed. In this case, said electromagnetic radiation is the pulse form electromagnetism source 11 which irradiates with said computer control reticle 30 and in which each pulse which turns image formation to the work 60 up irradiates with the portion from which that work 60 differs. For example, said computer control reticle 30 which can be set to SLM operates so that reconstruction is possible, so that all the arrays of the micro mirror may form an exact picture on the work 60 to each pulse.
[0089]
First, the binary pattern from a CAD layout is changed into the data set of SLM data. This data is transmitted to SLM and many micro mirrors change a position here according to the control electronic structure included in it. Thereby, a non-deviating pixel expresses the bright field on a work. Each specific cone of the radiation of a picture pixel defined above in said image plane corresponds to one specific object pixel of said computer control reticle 30 which can be used as a single micro mirror, for example. Each micro mirror can be made into a movable microelement type thing as mentioned above.
[0090]
The pattern on the work 60 is formed with many SLM stamps (stamps). These stamps should overlap selectively mutually. Grouping of both these stamps is carried out to a strip, and each strip has at least two stamps, and covers the overall length of a mask base material, or its part there. Said stamp on a strip is arranged as the line or sequence of a one-dimensional line, for example, a stamp.
[0091]
Drawing 5 is illustrating an example of the method by which the SLM stamp 150 is arranged on the work 60. The work 60 is covered by the lines 11, 12, 13, 14, 15, 16, 17, and 18 of the SLM stamp 150, the eight sequences c1, c2, c3, c4, c5, c6, c7, and c8 in this figure. Actually, although a work is covered with the SLM stamp of thousands, the pattern of only 8x8 is illustrated for clear-izing. Each stamp has many pixels and usual has millions of pixels. A strip can be made into the part of a perfect line, 11, 12, 13, 14, 15, 16, 17 and 18, or such a line. In accordance with the direction 11, 12, 13, 14, 15, 16, 17, and 18 of a strip, for example, lines, while said radiation source emits radiation to SLM so that it may carry out image formation of the pattern on it to a work, the supporting structure which carries a work moves. Completion of one strip will move the supporting structure in the equal direction substantially [size / a vertical direction and / of the stamp of this direction] substantially to the direction of a strip.
[0092]
A history (imprinting) is a cumulative material operation which appears as change in which an actuator/picture element position increases gradually, when all the parameters are kept constant in deflection status. When an actuator is neglected by sufficient time and non-deflection status, it is saved somewhat and appears (cure out). Both accumulation of a history and preservation of a history are nonlinear operations. Thus, it depends for the position at the given time not only on the electrostatic force which the actuator has received at that time but on the history of a deviation of this specific actuator. Therefore, the response of an actuator becomes inaccurate after a certain time. That is, the placement accuracy of the feature on the mask in a lithography process falls.
[0093]

In another embodiment of this invention, said history is reduced substantially completely at least.
[0094]
It may be longer than the time between the laser flashes of two times during time to process a perfect pattern on a work, and the interval of the time in which a pattern is not then formed may exist. Laser does not irradiate with SLM during the return stroke which is the time which needs said supporting structure body for another strip to begin, and pass and move from the end of one completed strip. The pattern on SLM is not acting on the last pattern on a mask during this return stroke. Therefore, it is possible to operate SLM by desirable arbitrary methods, although said cumulative history operation on another strip from one strip is reduced or neutralized during the time of a return stroke.
[0095]
When printing a specific pattern on a work, the deviation time and the grade of a deviation of each pixel may be monitored between each strip. For example, the reaction over the history under return stroke can be attained by shifting each actuator to reverse or a negative state. This can be performed by using the set of amplitude, address times, or the amplitude and the address times that deters correctly the history generated during exposure (singular number or plurality) of the strip (singular number or plurality) before that to each actuator in SLM.
[0096]
It is also possible to use the feedback system which monitors the momentary history operation generated about each actuator, and cancels it after that. This can be performed by using the monitor system based on an in-system (inch-system) camera which measures the contrast from each actuator, when the address of all the actuators is carried out to the same amplitude. Contrast differentiation (derivative) uses the collective address position of the actuator which is a possible peak price in the mask writer system, and measurement should be performed immediately after each strip. Then, the information from this measurement can be used and amplitude and address times can be fine-adjusted for history reaction addressing in the remaining portion of a return stroke.
[0097]
Instead of returning as time for reducing or canceling a history operation, and using a stroke, this cancellation or reducing method may be performed at what kind of time under processing of a perfect pattern. For example, a specific actuator may stop an image formation process, when [given] it is in given time and an address state, the quantity of a deviation may be taken into consideration in that case, or it is not necessary to put in.
[0098]
Cancellation of a history may be performed at one or more processes. After repealing each actuator from the information about deviation time and a deflection degree in the given time interval calculated from the picture photographed, for example by the CCD camera, further fine adjustment may be performed from the picture taken from SLM by which the history was canceled. every -- a SLM pixel is set as a given state and compensation in the address function for the further fine adjustment of that actuator or each pixel is performed by the grade of the difference from this state.
[0099]
Thus, although the specific embodiment of the equipment for patterning a work until now has been indicated, it does not have intention of such concrete reference being regarded as limitation to the range of this invention except for being indicated to Claims. Although this invention has been indicated in relation with the specific embodiment, it is understood that a person skilled in the art will think out also in the other embodiments, and it is meant by Claims until now with that in which all such change composition is included.
[Brief Description of the Drawings]
[0100]
[Drawing 1 a] The hysteresis by this invention is illustrating few 1st embodiment of movable microelement.
[Drawing 1 b] The hysteresis by this invention is illustrating few 2nd embodiment of movable microelement.
[Drawing 1 c] The hysteresis by this invention is illustrating few 3rd embodiment of movable microelement.
[Drawing 1 d] The hysteresis by this invention is illustrating few 4th embodiment of movable microelement.
[Drawing 1 e] The hysteresis by this invention is illustrating few 5th embodiment of movable microelement.
[Drawing 2]The abbreviated flow chart of the method of reducing the hysteresis by this invention is shown.
[Drawing 3]The schematic illustration of the deviation as a function of the potential difference between an address electrode and movable microelement is shown.
[Drawing 4]The optical system for patterning the base material coated by the electromagnetic radiation induction material layer is illustrated.
[Drawing 5]The composition of the SLM stamp on a work is illustrated.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[0100]
[Drawing 1 a] The hysteresis by this invention is illustrating few 1st embodiment of movable microelement.
[Drawing 1 b] The hysteresis by this invention is illustrating few 2nd embodiment of movable microelement.
[Drawing 1 c] The hysteresis by this invention is illustrating few 3rd embodiment of movable microelement.
[Drawing 1 d] The hysteresis by this invention is illustrating few 4th embodiment of movable microelement.
[Drawing 1 e] The hysteresis by this invention is illustrating few 5th embodiment of movable microelement.
[Drawing 2]The abbreviated flow chart of the method of reducing the hysteresis by this invention is shown.
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[Drawing 4]The optical system for patterning the base material coated by the electromagnetic radiation induction material layer is illustrated.
[Drawing 5]The composition of the SLM stamp on a work is illustrated.

[Translation done.]

WRITTEN AMENDMENT

[Written Amendment]
[Filing date]Heisei 15(2003) August 4 (2003.8.4)
[Amendment 1]
[Document to be Amended]Claims
[Item(s) to be Amended]Whole sentence
[Method of Amendment]Change
[The contents of amendment]
[Claim(s)]
[Claim 1]
Are estranged and arranged from the surface (20) which has at least one electrode, are movable microelement with little
hysteresis (10), and to said movable microelement (10). In that by which at least one return component (60, 70) is connected, an
address electrode (40) is allocated on said surface (20), electrostatic suction of said movable microelement (10) is possible, and
the address of said address electrode (40) is carried out to the 1st potential,
In time deltat before a predetermined pulse signal is first sent to said movable microelement (10) to said movable microelement
(10), A non-address state is set as the 2nd potential to form, and said movable component, Movable microelement (10) reduced
when it changes from said 2nd potential to the 3rd potential that forms an address state and said history operation decreases an
address state duty cycle of said movable microelement (10).
[Claim 2]
Movable microelement (10) which is the movable microelement (10) of Claim 1, and is returned to said non-address state after
said address state when said movable microelement (10) returns said 3rd potential to said 2nd potential.
[Claim 3]
Movable microelement (10) from which it is the movable microelement (10) of Claim 1, and said movable microelement (10) is
changed by electrostatic ********** after said 2nd potential state.
[Claim 4]
Are the movable microelement (10) of Claim 3 and said predetermined pulse signal, Movable microelement (10) which can clear
said address electrode (40) and potential difference between said movable microelement (10), and returns said movable
microelement (10) to said electrostatic ********** by this.
[Claim 5]
Movable microelement (10) which is Claim 1 or the movable microelement (10) of 4, and is the electromagnetic radiation by which
said predetermined pulse signal is turned to said movable microelement (10).
[Claim 6]
Movable microelement (10) which is Claim 1 or the movable microelement (10) of 4, and is an electrical signal with possible
making discharge of a capacitor by which loading is carried out in said 1st potential start while said predetermined pulse signal is
connected to said address electrode (40).
[Claim 7]
Movable microelement (10) which is the movable microelement (10) of Claim 1 and is maintained by time deltat+deltat' in which
said movable microelement is shorter than 10 ms, and said address state.
[Claim 8]
Movable microelement (10) which is the movable microelement (10) of Claim 1 and is maintained by time deltat+deltat' in which
said movable microelement is shorter than 10 microseconds, and said address state.
[Claim 9]
Are the movable microelement (10) of Claim 1 and a value of said 2nd potential, . In both maximum potential and minimum
potential by which an address is carried out to said address electrode (40), form non-deflection status. Movable microelement
(10) in which it is substantially equal to a half of maximum potential by which an address is carried out to said address electrode
(40), and said 3rd potential is substantially equal to said minimum potential by which an address is carried out to said address
electrode (40).
[Claim 10]
Movable microelement (10) which is one movable microelement of the Claims 1-9 (10), and is supported by a twist hinge (60) of a
couple with which said movable microelement (10) forms the axis-of-torsion heart along with the omitted portion.
[Claim 11]
Are one movable microelement of the Claims 1-9 (10), and said movable microelement (10), It is supported by member rotates
(65) of a couple which forms the tiltable shaft heart along with the omitted portion, and said return component, Movable
microelement (10) which is at least one crookedness hinge (70) which can permit that can come, simultaneously said movable
microelement (10) tilts by a circumference of said tiltable shaft heart while returning said movable microelement (10) in non-
deflection status.
[Claim 12]
Are the movable microelement (10) of Claim 10, and further, while returning said movable microelement in non-deflection status,
Movable microelement (10) which has at least one crookedness hinge which can permit that can come, simultaneously said
movable microelement (10) tilts by a circumference of said tiltable shaft heart or said axis-of-torsion heart.

Drawing selection Representative drawing
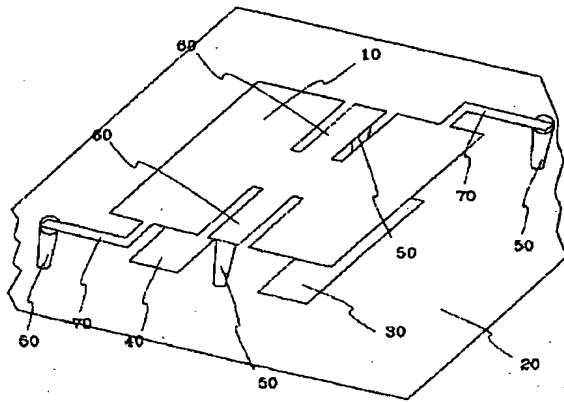
[Translation done.]

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(21) 出願番号	特願2002-563057 (P2002-563057)	(71) 出願人　503280547
(86) (22) 出願日	平成14年1月28日 (2002.1.28)	マイクロニック・レーザー・システムズ・
(85) 翻訳文提出日	平成15年8月4日 (2003.8.4)	エイビー
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(87) 国際公開日	平成14年8月15日 (2002.8.15)	アール・アンド・リーガル・ディパートメ
(31) 優先権主張番号	0100336-7	ント
(32) 優先日	平成13年2月5日 (2001.2.5)	(71) 出願人　503280570
(33) 優先権主張国	スウェーデン(SE)	フラウンホーファー−ゲゼルシャフト・ツ
		ア・フェルデルング・デア・アンゲヴァン
		テン・フォルシュング・エー・ファウ
		ドイツ連邦共和国　80636　ミューニ
		ック　レオナルトシュトラーセ　54
		(74) 代理人　100107308
		弁理士　北村　修一郎
		最終頁に続く

(54) 【発明の名称】可動マイクロ素子におけるヒステリシス又は履歴効果を減少させるための方法と装置

(57)【要約】

本発明は、少なくとも1つの電極を有する表面から離間して配置されて、履歴又はヒステリシス効果の少ない、可動マイクロ素子に関する。前記可動マイクロ素子には、少なくとも1つの復帰部材が接続されている。前記表面上にはアドレス電極が配設され、前記可動マイクロ素子を静電吸引可能である。前記アドレス電極は、第1電位にアドレスされる。前記可動マイクロ素子は、先ず、非アドレス状態を形成する第2電位に設定され、所定のパルス信号が発信される前の時間Δtにおいて、前記可動マイクロ素子は、前記第2電位から、アドレス状態を形成する第3電位に切り替えられる。前記可動マイクロ素子は、時間Δt＋Δt’の間、前記アドレス状態に維持される。本発明は、更に、空間光変調器（SLM）、加工物をパターニングするための装置、そして、可動マイクロ素子の履歴又はヒステリシス効果を低減する方法にも関する。
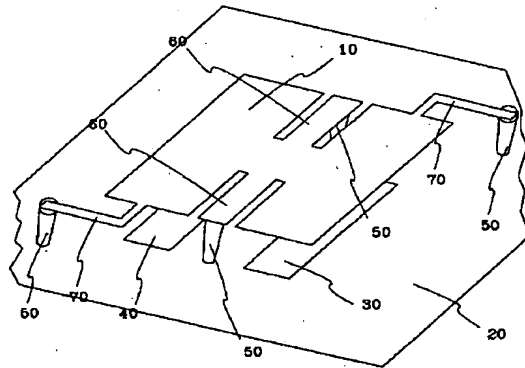
【特許請求の範囲】
【請求項１】
少なくとも１つの電極を有する表面（２０）から離間して配置されて、履歴効果の少ない、可動マイクロ素子（１０）であって、前記可動マイクロ素子（１０）には、少なくとも１つの復帰部材（６０，７０）が接続され、前記表面（２０）上にはアドレス電極（４０）が配設され、前記可動マイクロ素子（１０）を静電吸引可能であり、前記アドレス電極（４０）が、第１電位にアドレスされたものにおいて、
前記可動マイクロ素子（１０）は、先ず、所定のパルス信号が前記可動マイクロ素子（１０）に対して発信される前の時間Δｔにおいて、非アドレス状態を形成する第２電位に設定され、前記可動部材は、前記第２電位から、アドレス状態を形成する第３電位に切り替えられ、前記可動マイクロ素子（１０）が、時間Δｔ＋Δｔ’の間、前記アドレス状態に維持されることを特徴とする可動マイクロ素子（１０）。
【請求項２】
請求項１の可動マイクロ素子（１０）であって、前記可動マイクロ素子（１０）は、前記第３電位を前記第２電位へ戻すことによって、前記アドレス状態後に、前記非アドレス状態に戻される可動マイクロ素子（１０）。
【請求項３】
請求項１の可動マイクロ素子（１０）であって、前記可動マイクロ素子（１０）は、前記第２電位状態後に、静電非吸引状態に切り替えられる可動マイクロ素子（１０）。
【請求項４】
請求項３の可動マイクロ素子（１０）であって、前記所定パルス信号は、前記アドレス電極（４０）と、前記可動マイクロ素子（１０）との間の電位差をクリア可能であり、これにより、前記可動マイクロ素子（１０）を前記静電非吸引状態に復帰させる可動マイクロ素子（１０）。
【請求項５】
請求項１又は４の可動マイクロ素子（１０）であって、前記所定パルス信号は、前記可動マイクロ素子（１０）に向けられる電磁放射である可動マイクロ素子（１０）。
【請求項６】
請求項１又は４の可動マイクロ素子（１０）であって、前記所定パルス信号は、前記アドレス電極（４０）に接続されるとともに、前記第１電位をローディングされるコンデンサの放電を開始させることが可能な電気信号である可動マイクロ素子（１０）。
【請求項７】
請求項１～６のいずれかの可動マイクロ素子（１０）であって、前記時間Δｔ＋Δｔ’は、１０ｍｓよりも短い可動マイクロ素子（１０）。
【請求項８】
請求項１～６のいずれかの可動マイクロ素子（１０）であって、前記時間Δｔ＋Δｔ’は、１０μｓよりも短い可動マイクロ素子（１０）。
【請求項９】
請求項１の可動マイクロ素子（１０）であって、前記第２電位の値は、前記アドレス電極（４０）に対してアドレスされる最大電位と最小電位との両方において非偏向状態を形成する、前記アドレス電極（４０）に対してアドレスされる最大電位の半分に実質的に等しく、前記第３電位は、前記アドレス電極（４０）に対してアドレスされる前記最小電位に実質的に等しい可動マイクロ素子（１０）。
【請求項１０】
請求項１～９のいずれかの可動マイクロ素子（１０）であって、前記可動マイクロ素子（１０）は、その中間部分に沿って、捻れ軸心を形成する一対の捻りヒンジ（６０）によって支持されている可動マイクロ素子（１０）。
【請求項１１】
請求項１～９のいずれかの可動マイクロ素子（１０）であって、前記可動マイクロ素子（１０）は、その中間部分に沿って、傾動軸心を形成する一対の回動部材（６５）によって

支持され、前記復帰部材は、非偏向状態において前記可動マイクロ素子（１０）を復帰させるとともに、これと同時に、前記可動マイクロ素子（１０）が前記傾動軸心回りで傾動することを許容することが可能な少なくとも１つの屈曲ヒンジ（７０）である可動マイクロ素子（１０）。

【請求項１２】
請求項１０の可動マイクロ素子（１０）であって、更に、非偏向状態において前記可動マイクロ素子を復帰させるとともに、これと同時に、前記可動マイクロ素子（１０）が前記傾動軸心または前記捻れ軸心回りで傾動することを許容することが可能な少なくとも１つの屈曲ヒンジを有する可動マイクロ素子（１０）。

【請求項１３】
請求項１～９のいずれかの可動マイクロ素子（１０）であって、前記可動マイクロ素子（１０）は、その中間部分の１つに沿って、前記可動マイクロ素子（１０）を弛緩状態へ復帰させるとともに、これと同時に、前記可動マイクロ素子（１０）が前記少なくとも１つの電極を有する前記表面（２０）に対して垂直移動することを許容することが可能な一対の屈曲ヒンジ（７０）によって支持されている可動マイクロ素子（１０）。

【請求項１４】
請求項１～９のいずれかの可動マイクロ素子（１０）であって、前記可動マイクロ素子（１０）は、その中間部分の二つに沿って、前記可動マイクロ素子（１０）を弛緩状態に復帰させるとともに、これと同時に、前記可動マイクロ素子（１０）が、前記少なくとも１つの電極を有する前記表面（２０）に対して垂直移動することを許容することが可能な二対の屈曲ヒンジ（７０）によって支持されている可動マイクロ素子（１０）。

【請求項１５】
請求項１３又は１４のいずれかの可動マイクロ素子（１０）であって、前記屈曲ヒンジ（７０）は、多角形状の可動マイクロ素子（１０）の角部に取り付けられている可動マイクロ素子（１０）。

【請求項１６】
請求項１３又は１４のいずれかの可動マイクロ素子（１０）であって、前前記屈曲ヒンジ（７０）は、多角形状の可動マイクロ素子（１０）の面部に取り付けられている可動マイクロ素子（１０）。

【請求項１７】
請求項１０～１６のいずれかの可動マイクロ素子（１０）であって、前記屈曲ヒンジ（７０）の少なくとも１つおよび／又は前記捻れ軸心の少なくとも１つは、曲折形状である可動マイクロ素子（１０）。

【請求項１８】
請求項１～１７のいずれかの可動マイクロ素子（１０）であって、前記表面（２０）は、更に、前記アドレス電極（４０）から側方に離間した対向電極（３０）を有し、前記アドレス電極（４０）と前記対向電極（３０）とは、前記可動マイクロ素子（１０）を静電吸引可能である可動マイクロ素子（１０）。

【請求項１９】
請求項１８の可動マイクロ素子（１０）であって、前記所定パルス信号は、前記アドレス電極（４０）と前記対向電極（３０）との間の電位差をクリア可能であり、これによって、前記可動マイクロ素子（１０）を前記非アドレス状態へ復帰させる可動マイクロ素子（１０）。

【請求項２０】
請求項１８の可動マイクロ素子（１０）であって、前記所定パルス信号は、前記アドレス電極（４０）と前記対向電極（３０）との間の電位差をクリア可能であり、これによって、前記可動マイクロ素子（１０）を静電非吸引状態へ復帰させる可動マイクロ素子（１０）。

【請求項２１】
請求項１９～２０の可動マイクロ素子（１０）であって、前記所定パルス信号は、前記可

動マイクロ素子（１０）に向けられる電磁放射である可動マイクロ素子（１０）。
【請求項２２】
請求項１９～２０の可動マイクロ素子（１０）であって、前記所定パルス信号は、前記ア
ドレス電極（４０）に接続されるとともに、前記第１電位をローディングされるコンデン
サの放電をすることが可能な電気信号である可動マイクロ素子（１０）。
【請求項２３】
請求項１又は１９の可動マイクロ素子（１０）であって、前記所定パルス信号は、前記時
間Δｔ'が、前記所定パルス信号のパルス長と実質的に等しくなるように、前記時間Δｔ
＋Δｔ'と同期される可動マイクロ素子（１０）。
【請求項２４】
複数の反射部材を備える空間光変調器であって、前記反射部材が、請求項１～２３のいず
れかの可動マイクロ素子（１０）であることを特徴とする空間光変調器。
【請求項２５】
請求項２４の空間光変調器であって、前記反射部材は、１つの共通の素子ピンを介して１
つの電位に設定される空間光変調器。
【請求項２６】
請求項２３又は２４の空間光変調器であって、前記対向電極（３０）は、１つの共通の対
向ピンを介して１つの電位に設定される空間光変調器。
【請求項２７】
請求項２３～２６の空間光変調器であって、前記反射部材は、すべて、実質的に同じ時間
、アドレス状態にされる空間光変調器。
【請求項２８】
結像面に配置され、電磁放射に感応する加工物（６０）をパターニングするための装置で
あって、以下、
対物面に向けて電磁放射を放出するソース（１１）と、
前記対物面において前記電磁放射を受け、この電磁放射を前記結像面に配置された前記加
工物（６０）に向けて中継するように構成された、複数の反射素子を有するコンピュータ
制御焦点板（３０）とを有し、
ここで、前記コンピュータ制御焦点板（３０）が複数の反射素子を有するものにおいて、
前記反射素子は、請求項１～２３のいずれかの可動マイクロ素子であることを特徴とする
装置。
【請求項２９】
表面から離間して配置された可動マイクロ素子の履歴効果を低減させるための方法であっ
て、ここで前記表面が、少なくとも１つの電極を有するものにおいて、前記方法は以下の
工程：
前記可動マイクロ素子を、非アドレス状態を形成する第２電位に設定する工程と、
アドレス電極を第１電位にアドレスする工程であって、ここで前記アドレス電極は、前記
表面上に配置され、前記可動マイクロ素子を静電吸引可能である工程と、
前記可動マイクロ素子を、所定のパルス信号が発信される前の時間Δｔにおいて、前記第
２電位から、アドレス状態を形成する第３電位に切り替える工程と、
前記可動マイクロ素子を、時間Δｔ＋Δｔ'の間、前記アドレス状態に維持する工程と
を包含する方法。
【請求項３０】
請求項２９の方法であって、更に、以下の工程：
前記第３電位から前記第２電位へ前記可動マイクロ素子を切り替えることによって、前記
非アドレス状態に戻す工程を包含する方法。
【請求項３１】
請求項２９の方法であって、更に以下の工程：
前記可動マイクロ素子を、前記アドレス状態後に、静電非吸引状態に切り替える工程を包
含する方法。

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【請求項３２】
請求項３１の方法であって、更に以下の工程：
前記所定パルス信号によって、前記アドレス電極と、前記可動マイクロミラーとの間の電位差をクリアし、これにより、前記可動マイクロ素子を前記静電非吸引状態に復帰させる工程を包含する方法。
【請求項３３】
請求項２９～３２のいずれかの方法であって、前記所定パルス信号は、前記可動マイクロ素子に向けられる電磁放射信号である方法。
【請求項３４】
請求項２９～３２のいずれかの方法であって、前記所定パルス信号は、前記アドレス電極に接続されるとともに、前記第１電位をローディングされるコンデンサの放電を開始させることが可能な電気信号である方法。
【請求項３５】
請求項２９～３４のいずれかの方法であって、前記時間Δt＋Δt’は、１０ｍｓよりも短い方法。
【請求項３６】
請求項２９～３４のいずれかの方法であって、前記時間Δt＋Δt’は、１０μｓよりも短い方法。
【請求項３７】
請求項２９～３６のいずれかの方法であって、前記第２電位の値は、前記アドレス電極に対してアドレスされる最大電位と最小電位との両方において非偏向状態を形成する、前記アドレス電極に対してアドレスされる最大電位の半分に実質的に等しく、前記第３電位は、前記アドレス電極に対してアドレスされる前記最小電位に実質的に等しい方法。
【請求項３８】
請求項２９～３７のいずれかの方法であって、更に以下の工程：
前記可動マイクロ素子を、その中間部分に沿って、捻れ軸心を形成する一対の捻りヒンジによって支持する工程を包含する方法。
【請求項３９】
請求項２９～３７のいずれかの方法であって、更に以下の工程：
前記可動マイクロ素子を、その中間部分に沿って、傾動軸心を形成する一対の回動部材によって支持する工程であって、ここで、前記復帰部材は、非偏向状態において前記可動マイクロ素子を復帰させるとともに、これと同時に、前記可動マイクロ素子が前記傾動軸心回りで傾動することを許容することが可能な少なくとも１つの屈曲ヒンジである工程を包含する方法。
【請求項４０】
請求項３８～３９のいずれかの方法であって、更に、以下の工程：
少なくとも１つの屈曲ヒンジによって前記可動マイクロ素子を復帰させる工程を包含する方法。
【請求項４１】
請求項２９～３７のいずれかの方法であって、更に、以下の工程：
前記可動マイクロ素子を、その中間部分の１つに沿って、前記可動マイクロ素子を弛緩状態に復帰させるとともに、これと同時に、前記可動マイクロ素子が前記少なくとも１つの電極を有する前記表面に対して垂直移動することを許容することが可能な一対の屈曲ヒンジによって支持する工程を包含する方法。
【請求項４２】
請求項２９～３７のいずれかの方法であって、更に、以下の工程：
前記可動マイクロ素子を、その中間部分の二つに沿って、前記可動マイクロ素子を弛緩状態に復帰させるとともに、これと同時に、前記可動マイクロ素子が、前記少なくとも１つの電極を有する前記表面に対して垂直移動することを許容することが可能な一対の屈曲ヒンジによって支持する工程を包含する方法。

【請求項４３】
請求項４１～４２のいずれかの方法であって、前記屈曲ヒンジは、多角形の角部に取り付けられている方法。
【請求項４４】
請求項４１～４２のいずれかの方法であって、前記屈曲ヒンジは、多角形の面部に取り付けられている方法。
【請求項４５】
請求項３８～４４のいずれかの方法であって、前記屈曲ヒンジの少なくとも１つおよび／又は前記捻れ軸心の少なくとも１つは、曲折形状である方法。
【請求項４６】
請求項２９～４５のいずれかの方法であって、前記可動マイクロ素子は、請求項１～２３のいずれかの可動マイクロ素子である方法。
【請求項４７】
請求項２９～４６のいずれかの方法であって、更に、以下の工程：
前記所定パルス信号を、前記時間Δｔ’が、前記所定信号のパルス長と実質的に等しくなるように、前記時間Δｔ＋Δｔ’と同期させる工程を包含する方法。
【請求項４８】
請求項２９の方法であって、更に、以下の工程：
前記パルス信号が前記可動マイクロ素子に到達することを阻止しながら累積履歴作用を中和化する工程を包含する方法。
【請求項４９】
請求項４８の方法であって、前記中和化工程は、前記可動マイクロ素子が意図された作動中に偏向される状態に対してこれら個々の可動マイクロ素子を逆方向に偏向させることによって行われる方法。
【請求項５０】
請求項４９の方法であって、個々の可動マイクロ素子は、前記累積時間及び第２偏向方向に於ける偏向の度合いに応じて、所与の時間及び所与の偏向度、第１方向に偏向される方法。
【請求項５１】
請求項４８の方法であって、前記累積履歴作用の前記中和化は、加工物上の完全なパターンを構成する異なるストリップ間において行われる方法。
【請求項５２】
請求項４８の方法であって、前記累積履歴作用の前記中和化は、少なくとも１つの可動マイクロ素子が所定の累積時間偏向された後に行われる方法。
【発明の詳細な説明】
【技術分野】
【０００１】
本発明は、一般に機械部材におけるヒステリシス又は履歴効果を減少させるための技術、特に、可動マイクロ素子と、それにアドレスする方法とに関する。
【背景技術】
【０００２】
好適なミラー偏向のために必要なアドレス電圧を変化させる原因となる空間光変調器（ＳＬＭ）におけるミラー偏向量のヒステリシス又は履歴は、それによってミラーの偏向の精度が低下するために、問題である。この変化は、そのミラーが偏向された時間、偏向量、及び、ミラーがその偏向後に弛緩する必要がある時間に依存する。これらの現象の時定数は、数分間／数時間の範囲であるので、マスクライター又は、最新のＳＬＭ技術を使用した直接ライタにおける任意のパターンにおいて必要なアドレス電圧を予測し、それを補償することは事実上不可能である。
【０００３】
履歴を補償することにおける問題点は、ＳＬＭのミラーには、データが、行毎に、常に同

じ方向からロードされることにある。このことは、すべてのミラーが完全偏向状態にある時に、第１列の画素は、非常に高いデューティーサイクルを有し、最後の行においては、それらは非常に低いデューティーサイクルを有し、中間の行においては、中間のデューティーサイクルを有するということを意味する。従って、これらのデューティーサイクルを平均化するために、ＳＬＭを、二回目毎に、第１行及び最後の行からデータをロードするように再構成しない限り、履歴効果に対するバランスとして、集合的にアドレス可能な画素カウンタ電極を使用することも、不可能、又は、少なくとも非常に困難である。またそのように構成した場合でも、履歴は、依然としてパターン依存性であり、ミラーを頻繁に較正するか、もしくは、ＳＬＭのミラーを弛緩させるために、所定時間、そのシステムをアイドル状態に放置することが必要であろう。

【０００４】
従って、履歴効果の少ない、方法及び装置が当該分野において求められている。
【発明の開示】
【発明が解決しようとする課題】
【０００５】
上記背景に鑑みて、可動マイクロ素子及び、ＳＬＭのミラー部材等の、個々の可動マイクロ素子にアドレスするための方法において、履歴効果を減少させることが非常に重要である。
【０００６】
従って、本発明の課題は、上述した問題を解決する、又は、少なくとも軽減する、改良された可動マイクロ素子を提供することにある。
【課題を解決するための手段】
【０００７】
第１実施例において、本発明は、少なくとも１つの電極を有する表面から離間して配置されて、履歴効果又はヒステリシス効果の少ない、可動マイクロ素子を提供する。前記可動マイクロ素子には、少なくとも１つの復帰部材が接続されている。前記表面上にはアドレス電極が配設され、前記可動マイクロ素子を静電吸引可能である。前記アドレス電極は、第１電位にアドレスされる。前記可動マイクロ素子は、先ず、非アドレス状態を形成する第２電位に設定され、所定のパルス信号が発信される前の時間Δｔにおいて、前記可動マイクロ素子は、前記第２電位から、アドレス状態を形成する第３電位に切り替えられる。前記可動マイクロ素子は、時間Δｔ＋Δｔ’の間、前記アドレス状態に維持される。
【０００８】
本発明の別実施例において、前記可動マイクロ素子は、前記第３電位を前記第２電位へ戻すことによって、前記アドレス状態後に、前記非アドレス状態に戻される。
【０００９】
本発明の別実施例において、前記可動マイクロ素子は、前記アドレス状態後に、静電非吸引状態に切り替えられる。
【００１０】
本発明の別実施例において、前記所定パルス信号は、前記アドレス電極と、前記可動マイクロ素子との間の電位差をクリア可能であり、これにより、前記可動マイクロ素子を前記静電非吸引状態に復帰させる。
【００１１】
本発明の別実施例において、前記所定信号は、前記可動マイクロ素子に向けられる電磁放射信号である。
【００１２】
本発明の別実施例において、前記所定信号は、前記アドレス電極に接続されるとともに、前記第１電位をローディングされるコンデンサの放電を開始させることが可能な電気信号である。
【００１３】
本発明の別実施例において、前記時間Δｔ＋Δｔ’は、１０ｍｓよりも短い。

【０００１４】
本発明の別実施例において、前記時間Δｔ＋Δｔ’は、１０μｓよりも短い。
【００１５】
本発明の別実施例において、前記第２電位の値は、前記アドレス電極に対してアドレスされる最大電位と最小電位との両方において非偏向状態を形成する、前記アドレス電極に対してアドレスされる最大電位の半分に実質的に等しく、前記第３電位は、前記アドレス電極に対してアドレスされる前記最小電位に実質的に等しい。
【００１６】
本発明の更に別の実施例において、前記可動マイクロ素子は、その中間部分に沿って、捻れ軸心を形成する一対の捻りヒンジによって支持されている。
【００１７】
本発明の更に別の実施例において、前記可動マイクロ素子は、その中間部分に沿って、傾動軸心を形成する一対の回動部材によって支持され、前記復帰部材は、非偏向状態において前記可動マイクロ素子を復帰させるとともに、これと同時に、前記可動マイクロ素子が前記傾動軸心回りで傾動することを許容することが可能な少なくとも１つの屈曲ヒンジである。
【００１８】
更に別の実施例において、本発明は、更に、非偏向位置において前記可動マイクロ素子を復帰させるとともに、これと同時に、前記可動マイクロ素子が前記傾動軸心回りで回転することを許容することが可能な少なくとも１つの屈曲ヒンジを有する。
【００１９】
本発明の更に別の実施例において、前記可動マイクロ素子は、その中間部分の１つに沿って、前記可動マイクロ素子を弛緩状態に復帰させるとともに、これと同時に、前記可動マイクロ素子が前記少なくとも１つの電極を有する前記表面に対して垂直移動することを許容することが可能な一対の屈曲ヒンジによって支持されている。
【００２０】
本発明の更に別の実施例において、前記可動マイクロ素子は、その中間部分の二つに沿って、前記可動マイクロ素子を弛緩状態に復帰させるとともに、これと同時に、前記可動マイクロ素子が、前記少なくとも１つの電極を有する前記表面に対して垂直移動することを許容することが可能な二対の屈曲ヒンジによって支持されている。
【００２１】
本発明の更に別の実施例において、前記屈曲ヒンジは、多角形の角部に取り付けられている。
【００２２】
本発明の更に別の実施例において、前記屈曲ヒンジは、多角形の面部に取り付けられている。
【００２３】
本発明の更に別の実施例において、前記屈曲ヒンジの少なくとも１つおよび／又は前記捻れ軸心の少なくとも１つは、曲折形状である。
【００２４】
本発明の更に別の実施例において、前記表面は、更に、前記アドレス電極から側方に離間した対向電極を有し、前記アドレス電極と前記対向電極とは、前記可動マイクロ素子を静電吸引可能である。
【００２５】
本発明の更に別の実施例において、前記所定パルス信号は、前記アドレス電極と前記対向電極との間の電位差をクリア可能であり、これによって、前記可動マイクロ素子を前記非アドレス状態へ復帰させる。
【００２６】
本発明の更に別の実施例において、前記所定パルス信号は、前記アドレス電極と前記対向電極との間の電位差をクリア可能であり、これによって、前記可動マイクロ素子を静電非

吸引状態へ復帰させる。
【００２７】
本発明の更に別の実施例において、前記所定信号は、前記可動マイクロ素子に向けられる
電磁放射である。
【００２８】
本発明の更に別実施例において、前記所定信号は、前記アドレス電極に接続されるととも
に、前記第１電位をローディングされるコンデンサの放電をすることが可能な電気信号で
ある。
【０２９】
本発明の更に別の実施例において、前記所定パルス信号は、前記時間Δｔ’が、前記所定　　　　　10
信号のパルス長と実質的に等しくなるように、前記時間Δｔ＋Δｔ’と同期される。
【０３０】
本発明は、更に、複数の反射部材を備える空間光変調器に関し、ここで、前記反射部材は
、前記実施例のいずれかの可動マイクロ素子である。
【０３１】
本発明の別の実施例において、前記反射部材は、１つの共通の素子ピンを介して１つの電
位に設定される。
【０３２】
本発明の更に別の実施例において、前記対向電極は、１つの共通の対向ピンを介して１つ
の電位に設定される。　　　　　20
【０３３】
本発明の更に別の実施例において、前記反射部材は、すべて、実質的に同じ時間、アドレ
ス状態にされる。
【０３４】
本発明は、更に、結像面に配置され、電磁放射に感応する加工物をパターニングするため
の装置に関する。
【０３５】
第１実施例において、本発明は、対物面に向けて電磁放射を放出するソースと、前記対物
面において前記電磁放射を受け、この電磁放射を前記対物面に配置された前記加工物に向
けて中継するように構成された、複数の反射可動マイクロ素子を有するコンピュータ制御　　　　　30
焦点板とを提供し、ここで、前記コンピュータ制御焦点板が複数の反射マイクロ部材を有
するものにおいて、前記反射マイクロ部材は、前記実施例のいずれかの可動マイクロ素子
であることを特徴とする。
【０３６】
本発明は、更に、表面から離間して配置された可動マイクロ素子の履歴効果を低減させる
ための方法に関し、ここで、前記表面は、少なくとも１つの電極を有する。
【０３７】
第１実施例において、本発明は、以下の工程を包含する、
前記可動マイクロ素子を、非アドレス状態を形成する第２電位に設定する、
アドレス電極を第１電位にアドレスする、ここでアドレス電極は、前記表面上に配置され　　　　　40
、前記可動マイクロ素子を静電吸引可能である、
前記可動マイクロ素子を、所定のパルス信号が発信される前の時間Δｔにおいて、前記第
３電位から、アドレス状態を形成する第４電位に切り替える、
前記可動マイクロ素子を、時間Δｔ＋Δｔ’の間、前記アドレス状態に維持する。
【０３８】
別実施例において、本発明は、更に以下の工程を包含する、
前記第３電位から前記第２電位へ前記可動マイクロ素子を切り替えることによって、前記
非アドレス状態に戻す。
【０３９】
別実施例において、本発明は、更に以下の工程を包含する、　　　　　50

前記可動マイクロ素子を、前記アドレス状態後に、静電非吸引状態に切り替える。
【００４０】
別実施例において、本発明は、更に以下の工程を包含する、
前記所定パルス信号によって、前記アドレス電極と、前記可動マイクロ素子との間の電位
差をクリアし、これにより、前記可動マイクロ素子を前記静電非吸引状態に復帰させる。
【００４１】
本発明の別実施例において、前記所定信号は、前記可動マイクロ素子に向けられる電磁放
射信号である。
【００４２】
本発明の別実施例において、前記所定信号は、前記アドレス電極に接続されるとともに、
前記第１電位をローディングされるコンデンサの放電を開始させることが可能な電気信号
である。
【００４３】
本発明の別実施例において、前記時間Δｔ＋Δｔ’は、１０ｍｓよりも短い。
【００４４】
本発明の別実施例において、前記時間Δｔ＋Δｔ’は、１０μｓよりも短い。
【００４５】
本発明の別実施例において、前記第２電位は、前記アドレス電極に対してアドレスされる
最大電位と最小電位との両方において非偏向状態を形成する、前記アドレス電極に対して
アドレスされる最大電位の半分に実質的に等しく、前記第３電位は、前記アドレス電極に
対してアドレスされる前記最小電位に実質的に等しい。
【００４６】
更に別の実施例において、本発明は、更に以下の工程を包含する、
前記可動マイクロ素子を、その中間部分に沿って、捻れ軸心を形成する一対の捻りヒンジ
によって支持する。
【００４７】
更に別の実施例において、本発明は、更に以下の工程を包含する、
前記可動マイクロ素子を、その中間部分に沿って、傾動軸心を形成する一対の回動部材に
よって支持する、ここで、前記復帰部材は、非偏向状態において前記可動マイクロ素子を
復帰させるとともに、これと同時に、前記可動マイクロ素子が前記傾動軸心回りで回転す
ることを許容することが可能な少なくとも１つの屈曲ヒンジである。
【００４８】
更に別の実施例において、本発明は、更に、以下の工程を包含する、
少なくとも１つの屈曲ヒンジによって前記可動マイクロ素子を復帰させる。
【００４９】
更に別の実施例において、本発明は更に以下の工程を包含する、
前記可動マイクロ素子を、その中間部分の１つに沿って、前記可動マイクロ素子を弛緩状
態に復帰させるとともに、これと同時に、前記可動マイクロ素子が前記少なくとも１つの
電極を有する前記表面に対して垂直移動することを許容することが可能な一対の屈曲ヒン
ジによって支持する。
【００５０】
更に別の実施例において、本発明は、更に以下の工程を包含する、
前記可動マイクロ素子を、その中間部分の二つに沿って、前記可動マイクロ素子を弛緩状
態に復帰させるとともに、これと同時に、前記可動マイクロ素子が、前記少なくとも１つ
の電極を有する前記表面に対して垂直移動することを許容することが可能な一対の屈曲ヒ
ンジによって支持する。
【００５１】
本発明の別の実施例において、前記屈曲ヒンジは、多角形の角部に取り付けられている。
【００５２】
本発明の別の実施例において、前記屈曲ヒンジは、多角形の面部に取り付けられている。

【００５３】
更に別の実施例において、本発明は、更に以下の工程を包含する、
前記屈曲ヒンジの少なくとも１つおよび／又は前記捻れ軸心の少なくとも１つは、曲折形
状である。
【００５４】
本発明の別の実施例において、前記可動マイクロ素子は、前記実施例のいずれかの可動マ
イクロ素子である。
【００５５】
更に別の実施例において、本発明は、更に以下の工程を包含する、
前記所定パルス信号を、前記時間Δｔ’が、前記所定信号のパルス長と実質的に等しくな　　　10
るように、前記時間Δｔ＋Δｔ’と同期させる。
【発明を実施するための最良の形態】
【００５６】
本発明とその利点の更に完全な理解のために、添付図面を参照して以下の説明を参照する
。
【００５７】
図１ａは、本発明による履歴効果が少ない、可動マイクロ素子、たとえば、マイクロ機械
部材、の第１実施例を図示している。前記可動マイクロ素子は、たとえば、空間光変調器
（Ｓｐａｔｉａｌ　Ｌｉｇｈｔ　Ｍｏｄｕｌａｔｏｒ：ＳＬＭ）のミラーとすることがで
きる。前記ミラーは、電気入力の関数として該ミラー部材の偏向度を選択的に操作するべ　　　20
くアナログモードで、あるいは、最大偏向と非偏向とによって形成される該ミラー部材の
ＯＮ及びＯＦＦ状態を表すデジタルモードで作動可能である。前記ミラー部材の偏向は、
このミラー（可動マイクロ素子）が、いかに物理的に作用されるかに応じて、前記入力信
号の関数として、ほぼ線形であってもよいし、非線形であってもよい。
【００５８】
本実施例において、前記可動マイクロ素子１０は、その１つの中間部分に沿って、一対の
捻りヒンジ６０によって支持されたほぼ矩形の反射部材である。この反射部材は、たとえ
ば、多角形、円形、又は楕円形、等の任意の形状にすることができる。前記ヒンジは、そ
れに沿って捻り軸心を形成する。前記捻りヒンジは、前記可動マイクロ素子１０から延出
して、支持部材５０によって支持されている。この支持部材は、基材２０上に支持されて　　　30
いる。前記可動マイクロ素子１０、前記捻りヒンジ６０、前記支持部材５０及び前記基材
は、たとえば、ケイ素やアルミニウムなどの同じ材料から形成することができ、それらは
、当業者にとって周知のエッチング技術を使用して１つの基材からエッチングすることが
できるので、それらについて更に説明することは不要である。
【００５９】
前記基材は、更に、導電性アドレス電極４０と、オプションとしての導電性対向電極３０
とを有する。これらアドレス電極４０とオプションとしての対向電極３０とは、前記基材
２０内に形成された下方のアドレス回路（図示せず）に接続されている。前記アドレス電
極は、コンデンサに接続され、これらコンデンサは、前記電極に対してアドレスされるア
ドレス電圧を保持する。前記オプションの対向電極３０とアドレス電極４０とは、前記表　　　40
面２０上で互いに側方に離間され、前記可動マイクロ素子１０を静電吸引可能である。前
記捻りヒンジ６０は、前記可動マイクロ素子１０と共に回転又は捻れて、機械的エネルギ
としての復元力を提供する。前記可動マイクロ素子、前記オプションの対向電極３０及び
アドレス電極に対して電圧がかかっていない時は、前記可動マイクロ部材は、以下の説明
において、電気的非吸引状態として記載される、通常のフラットな又は非偏向位置にある
とされる。前記アドレス電圧をアドレス電極から対向電極にシフトすることによって、前
記可動マイクロ素子は、反対方向に回動させることができる。
【００６０】
図１ｂは、本発明による履歴効果の少ない、可動マイクロ素子の第２実施例を図示してい
る。この第２実施例は、前記第１実施例に加えて、前記可動マイクロ素子１０に接続され　　　50

るとともに、支持部材５０によって支持された二つのフレキシブルヒンジ７０を有する。
これらフレキシブルヒンジ７０も、前記可動マイクロ素子１０が前記捻りヒンジ６０によ
って形成される前記捻り軸心回りで偏向する時に、復元力を提供し、変形又は屈曲する。
この実施例において、前記フレキシブルヒンジ７０は、その端部の１つが前記支持部材５
０に接続され、その他端部が前記可動マイクロ素子１０に接続されたＬ形状である。これ
らフレキシブルヒンジの一方は、前記捻りヒンジの一方と同じ側に接続され、他方のフレ
キシブルヒンジは、他方の捻りヒンジと同じ側に接続され、これらフレキシブルヒンジは
、前記可動マイクロ素子上で対角線方向に互いに離間している。
【００６１】
　図１ｃは、本発明による履歴効果の少ない、可動マイクロ素子の第３実施例を図示してい　　　10
る。この実施例と前記第２実施例との相違点は、前記可動マイクロ素子１０が、前記捻れ
ヒンジ６０の代わりに二つの枢支部６５を有することにある。これら枢支部は、前記支持
部材５０によって支持されている。これら枢支部は、前記支持部材５０の上部に形成され
た凹部５５内に位置し、前記可動マイクロ素子２０のその傾動軸心回りでの傾動のみを許
容し、それがその位置から側方に外れて移動することは許容しないように、前記枢支部６
５のサイズに適合されている。
【００６２】
復元力は、前記可動マイクロ素子１０が、前記枢支部６０によって形成される前記傾動軸
心回りで偏向するときに、変形または屈曲するフレキシブルヒンジ７０によって提供され
る。この実施例において、前記フレキシブルヒンジ７０は、その端部の１つが前記支持部　　　20
材５０に接続され、その他端部が前記可動マイクロ素子１０に接続されたＬ形状である。
これらフレキシブルヒンジの一方は、前記枢支部の一方と同じ側に接続され、他方のフレ
キシブルヒンジは、他方の枢支部と同じ側に接続され、これらフレキシブルヒンジは、前
記可動マイクロ素子上で対角線方向に互いに離間している。
【００６３】
図１ｄは、本発明による履歴効果の少ない、可動マイクロ素子の第４実施例を図示してい
る。この第４実施例と図１－３を参照して記載した前述の実施例との相違点は、可動マイ
クロ素子１０が、少なくとも１つのアドレス電極４０が取り付けられた表面２０に対して
垂直な方向に上下移動することにある。フレキシブルヒンジ７０が、前記可動マイクロ素
子１０に接続されるとともに、支持部材５０によって支持されている。前記フレキシブル　　　30
ヒンジ７０は、復元力を提供し、前記可動マイクロ素子１０が、前記表面２０に対して実
質的に垂直方向に上下移動する時に、変形又は屈曲する。この実施例において、前記フレ
キシブルヒンジ７０は、その端部の１つが前記支持部材５０に接続され、その別の端部が
前記可動マイクロ素子１０に接続された矩形形状である。前記フレキシブルヒンジは、前
記矩形の可動マイクロ素子１０の二つ対向面に取り付けられている。好ましくは、前記ヒ
ンジは、前記可動マイクロ素子１０の対称軸心の１つと一致している。別の実施例におい
て、少なくとももう一対のフレキシブルヒンジ７０が、前記可動マイクロ素子１０に取り
付けられ、これらは、この可動マイクロ素子１０の別の対称軸と一致している。図１ｄの
実施例において、前記アドレス電極４０は、前記可動マイクロ素子１０と実質的に同じサ
イズで同じ形状であるが、このアドレス電極の形状とサイズを、共に、前記可動マイクロ　　　40
素子１０と異なるものとすることも可能である。前記アドレス電極は、又、複数のアドレ
ス電極４０に分割することも可能である。他の可動マイクロ素子（同じ画素の）を弛緩位
置に維持した状態で（可動マイクロ素子１０とアドレス電極４０との間に静電吸引力が無
い状態）、可動マイクロ素子１０を下方にシフトする（この部材に当たるべく使用される
波長の１／４だけ）ことによって、破壊的干渉が達成される。
【００６４】
図１ｅは、本発明による、履歴効果の少ない、可動マイクロ素子の第５実施例を図示して
いる。この第５実施例と前記第４実施例との相違点は、前記フレキシブルヒンジ７０がＬ
形状であり、これらフレキシブル部材７０の数が、２ではなく４であり、更に、それらの
各対が、対角対称軸心と実質的に一致していることにある。　　　50

【００６５】
図２は、本発明による、履歴効果を低減させる方法の略流れ図を示している。
【００６６】
第１工程１１０は、前記可動マイクロ素子１０を第２電位に設定する工程を表している。
前記第２電位は、たとえば、前記アドレス電極にアドレスされる最大電位の値の半分である電位とすることができる。前記第３電極は非アドレス状態を形成する。
【００６７】
第２工程１２０は、アドレス電極４０を第１電位にアドレスする工程を表している。前記第１電位は、最小電位と前記最大電位との間の任意の値にすることができ、ここで、前記最小電位は接地電位とすることができ前記最大電位はたとえば２０Ｖとすることができる。前記アドレス電極４０は、前記表面２０上に配置され、前記可動マイクロ素子１０を静電吸引可能である。
【００６８】
第３工程１３０は、前記可動マイクロ素子を、前記第２電位から、アドレス状態を形成する第３電位に切り替える工程を表している。この第３電位への切り替えは、所定のパルス信号が発信される前の時間Δｔに行われる。前記第３電位は、たとえば、接地電位とすることができる。
【００６９】
第４工程１４０は、前記可動マイクロ素子を、一実施例では１０ｍｓよりも短く、別の実施例では１０μｓよりも短い、Δｔ＋Δｔ'に等しい時間、前記アドレス状態に維持する工程を表している。Δｔ'は、たとえば、そのコンデンサのタイプとサイズとに応じて数μｓ又はそれ以下とされる、コンデンサを放電するための時間に対応したものとすることができる。Δｔは、サブ秒の範囲の任意の値、より好ましくは、約１０ｍｓ以下、最も好ましくは１０μｓ以下の値に設定することができる。Δｔは、通常、Δｔ'よりも長いが、その反対の構成も適用可能である。前記所定信号は、たとえば、パルスレーザなどの、パルス電磁放射ビームとすることができる。Δｔ'は、一実施例において、前記パルス信号のパルス長と同期される。
【００７０】
前記時間Δｔ＋Δｔ'前記アドレス状態にされた後、前記可動マイクロ素子は、前記第２電位に戻されるか、もしくは、静電非吸引状態へ切り替えられる。
【００７１】
空間光変調器は、一次元列又は二次元アレイ状に配置された可動マイクロ素子のタイプとすることができる複数のミラーを備えることができる。前記ＳＬＭにおいて、すべての可動マイクロ素子、すなわち、ミラー表面は、１つの電圧面に接続することができ、入力ピンの１つ、所謂素子ピンにおいてこの平面にアドレスすることが可能である。同じことは、前記基材２０上のすべての対向電極３０にも当てはまる。すなわち、それらは、所謂対向ピンを使用して共にアドレス可能である。前記対向電極３０が接地電位に維持されているとき、前記アドレス電極は、接地電位にアドレスされ、可動マイクロ素子は、前記第３又は第４電位のいずれかに設定され、アドレス電極と可動マイクロ素子との間の電位差は、対向電極と可動マイクロ素子との間の電位差に等しいので、可動マイクロ素子は偏向されない。しかしながら、その厚みによっては、可動マイクロ素子の両エッジ間に小さな下方への曲げ部を設けることも可能である。この曲げ部は、前記可動マイクロ素子の厚みを一定として、この可動マイクロ素子にかかる電圧の増加に伴って増加する。前記ＳＬＭのすべてのミラーは、前記第３電位から前記第４電位へ、すなわち、前記非アドレス状態から前記アドレス状態へ、実質的に同時に切り替えられる。ＳＬＭのすべてのミラーは、又、実質的に同じ時間（Δｔ＋Δｔ'）前記アドレス状態にあり、これによって、これらミラー部材の履歴効果を除去、又は少なくとも低減する。これらミラー部材がアドレス状態にある時間が短いほど、これらミラー部材はヒステリシス効果（履歴効果）によって影響される度合いが少ない。すなわち、ミラー部材がアドレス状態にある時間の割合として定義されるデューティーサイクルが短いほど、前記ヒステリシス効果によるミラー部材への

影響は少なくなる。ミラー部材は、前記アドレス状態に短時間留まるだけでなく、ミラー部材全部が、実質的に同じ時間、すなわちΔt＋Δt’だけ、前記アドレス状態に留まるのである。
【００７２】
もしも可動マイクロ素子が１０Ｖに設定され対向電極が接地電位に維持されるならば、可動マイクロ素子１０は、アドレス電極が最低電圧０Ｖにアドレスされる場合と最大電圧２０Ｖとにアドレスされる場合との両方において、実質的に非偏向状態に留まることになる。これは、静電気力において電圧の符号は重要ではなく、それは常に吸引状態であるということを認識することによって理解することができる。アドレス電極と可動マイクロ素子との間の電位差の関数としての偏向の一例が図３に図示されている。図３において、可動部材は、ゼロ電位にあり、偏向度を交互に上下に動かして測定しながら、アドレス電極の電位が変化されている。この図において、可動マイクロ素子は、ある電位差（この例では１０Ｖ）以下では実質的に非偏向状態であることが理解できる。可動マイクロ素子とアドレス電極との間の電磁力は、前記捻りヒンジ６０（単数又は複数）および／又はフレキシブルヒンジ７０の機械的復元力によって反作用を受ける。可動マイクロ素子に取り付けられたこれら捻りヒンジおよび／又はフレキシブルヒンジのタイプと数とに応じて、アドレス電極と可動マイクロ素子との間の電位差の関数としての前記偏向は変化可能である。
【００７３】
このことは、回転部材に対して１０Ｖを使用して対応する回転部材を実質的に偏向させることなく、すべての画素（すなわち、回転部材）にアドレスすることが可能であるということを意味する。たとえば、前記可動マイクロ素子に向けられた前記電磁放射信号とすることができる、所定の信号の直前に、可動マイクロ素子に対する電圧が０ボルトにシフトすると、すべての可動マイクロ素子は、同時に前記所望偏向状態になる。前記電磁放射が可動マイクロ素子に当たると、基材上の前記アドレス電極に接続されたすべてのコンデンサが放電され、可動マイクロ素子は、即座に前記非偏向、電磁非吸引状態に戻る。このようにして、すべての可動マイクロ素子を偏向するデューティーサイクルを、ミラー電圧のスイッチング時間に基づいて、非常に小さなものとして維持することができる。もしも、Δt＋Δt’が１０マイクロ秒に維持されるならば、前記パルス信号の周波数が１０００Ｈｚであるとすると、完全偏向状態のデューティーサイクルは１％になる。
【００７４】
前記アドレス電極が、前記最大又は最小（接地）電位にアドレスされ、可動マイクロ素子が最大電位の値の半分に設定され、対向電極が接地電位に維持された時、可動マイクロ素子は偏向されず、アドレスされない。最大電位と最小電位との間の各値の場合、可動マイクロ素子は偏向され、アドレスされない。最悪のケースは、アドレス電圧が最大値の値の半分である場合である。この場合、アドレス電極と可動マイクロ素子は共に１０Ｖであるため、それらの間に力は発生しない。次に、対向電極が１０Ｖに対応する力によって可動マイクロ素子を下方に引っ張る。しかしながら、幸運なことに、この偏向は、図３から理解されるように、可動マイクロ素子の非線形挙動により、比較的小さなものである。
【００７５】
図４は、電磁放射感応材の層によってコーティングされた加工物６０をパターニングするための装置１００の実施例を図示している。この装置１００は、電磁放射を放出するソース１１と、第１レンズ系５０と、コンピュータ制御焦点板３０と、第２レンズ系２０と、空間フィルタ７０と、第３レンズ系４０と、加工物６０とを有する。
【００７６】
前記ソース１１は、７８０ｎｍから約２０μｍまでとして定義される赤外線（ＩＲ）から、本出願においては、１００ｎｍから、その放射が電磁放射として扱われることが可能な限りの低い波長の範囲として定義される極紫外線（ＥＵＶ）までの波長範囲の放射線を放出可能である。このソース１１は、放射線をパルス状又は連続状に放出する。連続放射線ソース１１からの放出放射線は、この放射線ソース１１と前記コンピュータ制御焦点板３０との間の放射線経路に位置するシャッタによってパルス状放射線に形成することが可能

である。一例として、前記放射線ソース１１は、パルス出力２４８ｎｍ、パルス長約１０
ｎｓ、反復速度１０００ＨｚのＫｒＦエキシマレーザとすることができる。前記反復速度
は、１０００Ｈｚ以下であってもよいし、１０００Ｈｚ以上であってもよい。前記第２レ
ンズ系２０は、単純なレンズ又は、複数のレンズのアセンブリとすることができる。この
第２レンズ系２０は、前記放射線ソース１１から放出された放射線を、前記コンピュータ
制御焦点板３０の表面上に均一に分配する。
【００７７】
前記第２レンズ系２０は、無限遠にその射出ひとみを有することができ、このことは、放
射線の円錐の中央軸心が平行であるということを意味する。前記対物面は、前記コンピュ　　　　　10
ータ制御焦点板３０の位置と一致し、この実施例では、前記放射線円錐の中央軸心は、前
記対物面において平行である。前記コンピュータ制御焦点板３０は、空間光変調器（ＳＬ
Ｍ）とすることができる。この実施例では、このＳＬＭは、前記加工物６０全体をパター
ニングするのに必要なすべての情報を単一の瞬間に有する。
【００７８】
空間光変調器３０は、反射式又は透過式のものとすることができる。図１に図示された実
施例において、前記ＳＬＭは、反射式ＳＬＭである。反射式空間光変調器は二つのタイプ
、すなわち、偏向式と位相式、がある。これらの間の違いは、特にマイクロミラーの場合
、小さなものに見えるかもしれないが、位相式ＳＬＭは、破壊的干渉によって反射方向の
ビームを消すのに対して、偏向式ＳＬＭの画素は、反射ビームが、結像レンズの口径を外　　　　　20
れるように、反射ビームを片側に幾何学的に偏向させる。通常、偏向式ＳＬＭのマイクロ
ミラーは、位相式ＳＬＭのマイクロミラーと比較して、マイクロミラーの表面がフラット
である、弛緩したＳＬＭの表面によって形成されるフラット位置からより大きく変位する
。本発明によって行われるような超精密パターニングのためには、位相式ＳＬＭの方が偏
向式ＳＬＭよりも優れている。
【００７９】
第１に、位相式ＳＬＭは、その表面のすべてのパーツ、更に、ヒンジ、支持ポストが、前
記破壊的干渉に関与し、完全消衰を達成することが可能であるため、コントラストがより
優れている。
【００８０】
第２に、放射線を片側に偏向することによって作用するシステムは、中間変更角度におい　　　　　30
て光軸回りで対称に形成することが困難であり、焦点が変更された場合に機能不安定性が
発生する虞がある。位相式ＳＬＭは、マイクロ加工ミラー、所謂マイクロミラー、又は、
支持基材上の連続ミラー面によって構築することができ、前記ミラー面は、電気信号を使
用して変形することが可能である。
【００８１】
たとえば、前記連続ミラーは、静電電界によって制御される粘弾性層を使用することがで
きるが、特に数ナノメートル程度の変形で十分である非常に短い波長の場合には、電界又
はその他の電気的、磁気的、又は熱的に制御される反射面によって変形される圧電固体デ
ィスクを使用することも同様に可能である。本出願の以下の記載においては、静電制御マ
イクロミラーマトリクス（一次元又は二次元）を前提としているが、それらの変調メカニ　　　　　40
ズムとして、ＬＣＤ結晶又は電気光学材料に基づく透過式又は反射式ＳＬＭや、圧電式又
は電気歪動作を使用したマイクロ機械式ＳＬＭ等の、上述したようなその他の構成も可能
である。
【００８２】
前記ＳＬＭは、コンピュータからの別々の入力によって変調される出力放射線を発生する
プログラマブル装置である。ＳＬＭは、コンピュータから供給されるデータに応答して、
光輝又は暗画素の発生を通じてマスクの作用をシミュレートする。たとえば、位相式ＳＬ
Ｍは、エッチングされた固体ミラーのアレイである。各マイクロミラー部材は、別の支持
ポスト又は隣接するミラーのいずかによって支持することが可能な、捻りヒンジによって
ケイ素基材の上方に懸架されている。これらのマイクロミラー部材の下方にアドレス電極　　　　　50

が配置されている。１つのマイクロミラーは、対物面に１つの画素を表す。結像面の画素は、ここでは、マイクロミラーと同じ幾何学形状を有するものとして定義されるが、その光学系、すなわち、その光学系が拡大式であるか、それとも非拡大式であるのかに応じて、大きいか、小さいかによってそのサイズは異なったものとすることができる。

【００８３】

前記マイクロミラーとアドレス電極とは、コンデンサとして作用し、マイクロミラーに対する電圧に対して、アドレス電極に対して当てられる電圧によって、マイクロミラーを懸架している前記捩りヒンジを捩り、これによって、マイクロミラーが回転することを許容し、それによって位相差を作り出す。与えられる電圧に応じて、マイクロミラーの回転は、フラット位置から完全回転位置までのいずれの状態もとることができる。その辺の長さが約１６μｍの実質的に方形の表面を有する完全回転状態のマイクロミラーは、通常８ｍＲａｄである。より一般的には、前記完全回転マイクロミラーは、回転軸心に対して平行なエッジでの測定で、使用される波長の１／４回転するか、若しくは、前記表面に対して垂直に移動するマイクロミラーの場合は、最大状態と最小状態との間の差は、前記マイクロミラーの表面に対して平行な測定で、使用される波長の１／４である。

【００８４】

投影システム８０は、この実施例において、前記第３レンズ系４０と、空間フィルタ７０と、前記第１レンズ系５０とを有する。前記第３レンズ系４０と、空間フィルタ７０とは、協働で、一般にフーリエフィルタと呼ばれているものを形成する。

【００８５】

前記空間フィルタ７０は、この実施例では、プレートに形成された穴である。この穴は、一次およびより高次の次数に回折される実質的にすべての回折次数を阻止するように寸法構成及び配置構成されており、たとえば、前記穴は、前記第３レンズ系４０からの焦点距離位置に配置することができる。反射された放射線は、同時に前記第１レンズ系５０のひとみ面としても作用する焦点面において第３レンズ系４０によって集められる。前記穴は、ＳＬＭ中のアドレスされたマイクロミラーの一次又はより高次の回折次数の光をカットアウトし、これに対して、非アドレスミラー表面からの放射線はこの穴を通過することができる。その結果、従来のリトグラフィと同様、加工物６０上で強度変調された空間像が形成される。最適な画像コントラストのためには、すべての画素が変更されたＳＬＭの回折パターンは、ゼロ次数の放射線無しで、一次及びそれより高次の回折次数の光のみを含むものであるべきである。

【００８６】

前記第１レンズ系５０は、この実施例では、無限縁にその射出ひとみを有している。すなわち、加工物６０の位置によって形成される結像面の放射線の円錐の中心軸心は平行である。

【００８７】

前記加工物６０は、半導体デバイスやディスプレイパネル用のフォトマスクなどの、感光面を備えた基材とすることができる。それは、又、感光層によってコーティングされた半導体ウエハとすることも可能である。本発明は、半導体デバイスパターン、ディスプレイパネル、一体型光デバイス、及び電子相互接続構造の直接パターニングのみに用途を有するものではないので、それは、セキュリティパターニング等のその他のタイプのパターニングにも利用可能である。ここでパターニングという用語は、フォトレジスト、及び写真乳剤の露光のみならず、放射線又は熱によって起動されるアブレーション又は化学的プロセス等の他の放射線感応媒体（たとえば、ドライプロセスペーパー）に対する放射線の作用も意味する、広い意味に理解されるべきである。本発明は、又、加工されたウエハが、放射線によって再加工される、ウエハ修復にも利用可能である。

【００８８】

前記加工物６０は、一定の速度で移動する移動ステージ上に配置することも可能である。この場合、前記電磁放射線は、前記コンピュータ制御焦点板３０を照射し、加工物６０に上に結像される各パルスが、その加工物６０の異なる部分を照射する、パルス状電磁ソー

ス１１である。たとえばＳＬＭとすることができる前記コンピュータ制御焦点板３０は、そのマイクロミラーの全アレイが、各パルスに対して加工物６０上に正確な画像を形成するべく再構成可能に作動する。

【００８９】

最初に、ＣＡＤレイアウトからの二値パターンが、ＳＬＭデータのデータセットに変換される。このデータがＳＬＭに転送され、ここで、それに組み込まれた制御電子構造によって、多数のマイクロミラーが位置を変える。これにより、非偏向画素は、加工物上の明るい領域を表す。前記画像平面において前に定義された特定の画像画素の放射線の各円錐は、たとえば、単一のマイクロミラーとすることができる、前記コンピュータ制御焦点板３０の１つの特定のオブジェクト画素に対応する。各マイクロミラーは、上述したように可動マイクロ素子タイプのものとすることができる。

【００９０】

加工物６０上のパターンは、多数のＳＬＭスタンプ（ｓｔａｍｐｓ）によって形成される。これらのスタンプは、互いに部分的に重なり合ったものとすることができる。これらのスタンプは、ストリップ状に共にグループ化され、そこで、各ストリップは、少なくとも二つのスタンプを有し、マスク基材の全長、又はその一部をカバーする。ストリップ上の前記スタンプは、一次元の線、たとえば、スタンプの行又は列として配置される。

【００９１】

図５は、ＳＬＭスタンプ１５０が加工物６０上に配置される方法の一例を図示している。この図において、加工物６０は、ＳＬＭスタンプ１５０の線１１，１２，１３，１４，１５，１６，１７，１８と、８つの列ｃ１，ｃ２，ｃ３，ｃ４，ｃ５，ｃ６，ｃ７，ｃ８によってカバーされている。実際には、加工物は、数千のＳＬＭスタンプによってカバーされるが、明瞭化のために、８ｘ８のみのパターンが図示されている。個々のスタンプは、多数の画素、通常は、数百万の画素を有する。ストリップは、完全な線、１１，１２，１３，１４，１５，１６，１７，１８又はそのような線の一部とすることができる。前記放射線ソースが、加工物に対してその上にパターンを結像するべくＳＬＭに対して放射線を放出しながら、加工物を載せる支持構造はストリップの方向、たとえば、線１１，１２，１３，１４，１５，１６，１７，１８に沿って移動する。１つのストリップを完了すると、支持構造は、ストリップの方向に対して実質的に垂直な方向、そして、この方向のスタンプのサイズに実質的に等しい方向に移動する。

【００９２】

履歴（ｉｍｐｒｉｎｔｉｎｇ）は、すべてのパラメータを偏向状態において一定に保ったときに、アクチュエータ／画素位置の漸進的に増大する変化として現れる、累積的材料作用である。更に、それは、アクチュエータが、十分な時間、非偏向状態に放置された時に、多少保存されて（ｃｕｒｅ　ｏｕｔ）現れる。履歴の蓄積と履歴の保存とは共に非線形な作用である。このように、所与の時点における位置は、その時点においてアクチュエータが受けている静電力のみならず、この特定のアクチュエータの偏向の履歴にも依存する。従って、アクチュエータのレスポンスは、ある時間後において不正確になる。すなわち、リトグラフィープロセスにおけるマスク上のフィーチャーのプレースメント精度が低下する。

【００９３】

本発明の別実施例において、前記履歴は、完全に、又は少なくとも大幅に低減される。

【００９４】

加工物上に完全なパターンを加工する時間の間、二回のレーザ閃光間の時間よりも長く、その時にパターンが形成されない時間の間隔が存在するかもしれない。前記支持構造体が１つの完了したストリップの端部からもう一つのストリップの始めへ移動するのに必要な時間である戻りストローク中、レーザは、ＳＬＭを照射しない。この戻りストローク中は、ＳＬＭ上のパターンは、マスク上の最終パターンに作用していない。従って、戻りストロークの時間中に、１つのストリップからもう一つのストリップへの前記累積的履歴作用を低減又は中和するのに望ましい任意の方法でＳＬＭを作動させることが可能である。

【００９５】
加工物上に特定のパターンをプリントする時に、個々の画素の偏向時間とその偏向の程度を、各ストリップの間にモニタしてもよい。たとえば、戻りストローク中における履歴に対する反作用は、各アクチュエータを逆又は負の状態にシフトさせることによって達成することができる。これは、ＳＬＭ中の各アクチュエータに対して、その前のストリップ（単数又は複数）の露光（単数又は複数）中に発生した履歴を正確に抑止する、振幅、アドレス時間、又は、振幅とアドレス時間のセットを使用することによって行うことができる。

【００９６】
更に、各アクチュエータに関して発生した瞬間的な履歴作用をモニタし、その後それをキャンセルする、フィードバックシステムを使用することも可能である。これは、すべてのアクチュエータが同じ振幅にアドレスされる時に各アクチュエータからのコントラストを測定する、イン・システム（ｉｎ－ｓｙｓｔｅｍ）カメラに基づくモニタシステムを使用することによって行うことができる。測定は、コントラスト微分（ｄｅｒｉｖａｔｉｖｅ）がそのマスクライターシステムに於ける可能な最高値であるアクチュエータの集合的アドレス位置を使用して、各ストリップの直後に行われるべきである。その後、この測定からの情報を使用して、戻りストロークの残り部分中の履歴反作用アドレシングのために振幅とアドレス時間を微調節することができる。

【００９７】
履歴作用を低減又は取り消すための時間として戻りストロークを使用する代わりに、この取り消しまたは低減方法を、完全なパターンの加工中のいかなる時点において実行してもよい。たとえば、特定のアクチュエータが、所与の時間、アドレス状態であった所与の時点において画像形成プロセスを停止してもよく、その場合、偏向の量を考慮に入れてもよいし、又は入れなくてもよい。

【００９８】
履歴の取り消しは、１つ以上の工程で行ってもよい。偏向時間と偏向度とに関する情報から、又は、たとえばＣＣＤカメラによって撮られた画像から計算された、所与の時間間隔において個々のアクチュエータを無効にした後、履歴が取り消されたＳＬＭから採られた画像から更なる微調節を行ってもよい。各ＳＬＭ画素は所与の状態に設定され、この状態からの相違の程度によって、そのアクチュエータの更なる微調節、又は、個々の画素のためのアドレス機能における補償が行われる。

【００９９】
このように、これまで、加工物をパターニングするための装置の特定の実施例を開示してきたが、このような具体的言及が、特許請求の範囲に記載されていることを除いて、本発明の範囲に対する限定として見なされることは意図されていない。更に、これまで本発明を、その特定の実施例との関連において記載してきたが、当業者はその他の実施例にも想到するであろうと理解され、特許請求の範囲には、そのような改変構成がすべて含まれるものと意図される。

【図面の簡単な説明】

【０１００】
【図１ａ】本発明による履歴効果が少ない、可動マイクロ素子の第１実施例を図示している。

【図１ｂ】本発明による履歴効果が少ない、可動マイクロ素子の第２実施例を図示している。

【図１ｃ】本発明による履歴効果が少ない、可動マイクロ素子の第３実施例を図示している。

【図１ｄ】本発明による履歴効果が少ない、可動マイクロ素子の第４実施例を図示している。

【図１ｅ】本発明による履歴効果が少ない、可動マイクロ素子の第５実施例を図示している。

【図2】本発明による履歴効果を低減させる方法の略流れ図を示している。
【図3】アドレス電極と可動マイクロ素子との間の電位差の関数としての偏向の略図を示している。
【図4】電磁放射感応材層によってコーティングされた基材をパターニングするための光学システムを図示している。
【図5】加工物上のSLMスタンプの構成を図示している。

【国際公開パンフレット】

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(54) Title: A METHOD AND A DEVICE FOR REDUCING HYSTERESIS OR IMPRINTING IN A MOVABLE MICRO-ELEMENT

(57) Abstract: The present invention relates to a movable micro element with reduced imprinting or hysteresis effect arranged spaced apart from a surface comprising at least one electrode. At least one restoring element is connected to said movable micro element. An address electrode is arranged on said surface and capable to electrostatically attract said movable micro element. Said address electrode is addressed to a first potential. Said movable micro element is first set to a second potential defining a non addressed state and at a time period Δt before a predetermined pulsed signal is emitted said movable micro element is switched from said second potential to a third potential defining a addressed state. Said movable micro element is kept in said addressed state for a time period of $\Delta t + \Delta t'$. The invention also relates to a Spatial Light Modulator (SLM), an apparatus for patterning a workpiece and a method of reducing an imprinting or hysteresis effect of a movable micro element.

WO 02/063371 A1

WO 02/063371 A1 |||||||||||||||||||||||||||||||||

1

A method and a device for reducing hysteresis or imprinting in a
movable micro-element

TECHNICAL FIELD

The present invention relates in general to techniques for
5   reducing hysteresis or imprinting effects in mechanical
elements, and in particular to a movable micro-element and a
method for addressing the same.

DESCRIPTION OF THE BACKGROUND ART

Hysteresis or imprinting of mirror deflection amplitude in
10   Spatial Light Modulators (SLM), which leads to a shift in a
required address voltage for a preferred mirror deflection, is
a problem since it reduces the accuracy of the mirror
deflection. This shift depends on an amount of time that the
mirror has been deflected, an amplitude of the deflection and a
15   time that the mirror has had to relax after said deflection.
The time constants for these phenomena are in the region of
minutes/hours making it virtually impossible to predict and
compensate the required address voltages for an arbitrary
pattern in a mask writer or a direct writer using a state of
20   the art SLM technology.

A problem with a compensation for the imprinting is that the
mirrors in the SLM are loaded with data row by row, always from
the same direction. This means that with all mirrors in a fully
25   deflected state the first row pixels will have a very high
duty-cycle while in the last row they will have a very low
duty-cycle and the intermediate rows will have intermediate
duty-cycles. It is therefore also impossible, or at least very
difficult, to use a collectively addressable pixel counter
30   electrode as a balance for the imprinting effect unless the SLM
is redesigned to load the data from the first and the last row
every second time to average the duty-cycles. Even then the

2

imprinting would still be pattern dependent and it would be
necessary to often calibrate the mirrors or leave the system
idle for a period of time to let the mirrors in the SLM relax.

5   Therefore, there is a need in the art for a method and an
apparatus with reduced imprinting effect.

SUMMARY OF THE INVENTION

10   In view of the foregoing background, in the movable micro-
elements and in the method for addressing individual movable
micro-elements, such as for example mirror elements in a SLM, it
is critical to reduce the imprinting effect.

15   Accordingly, it is an object of the present invention to provide
an improved movable micro-element, which overcomes or at least
reduces the above-mentioned problem.

In a first embodiment, the invention provides a movable micro-
20   element with reduced imprinting effect or hysteresis effect
arranged spaced apart from a surface comprising at least one
electrode. At least one restoring element is connected to said
movable micro-element. An address electrode is arranged on said
surface and capable to electrostatically attract said movable
25   micro-element. Said address electrode is addressed to a first
potential. Said movable micro-element is first set to a second
potential defining a non addressed state and at a time period
Δt before a predetermined pulsed signal is emitted said
movable micro-element is switched from said second potential to
30   a third potential defining an addressed state. Said movable
micro-element being in said addressed state for a time period
of $\Delta t + \Delta t'$.

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In another embodiment of the invention said movable micro-element is switched back into said non addressed state after being in said addressed state by switching said third potential back to said to said second potential.

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In another embodiment of the invention said movable micro-element is switched into an electrostatically unattracted state after being in said addressed state.

10   In another embodiment of the invention said predetermined pulsed signal is capable to clear out a potential difference between said address electrode and said movable micro-element and thereby restoring said movable micro-element to said electrostatically unattracted state.

15

In another embodiment of the invention said predetermined signal is an electromagnetic radiation signal directed onto said movable micro-element.

20   In another embodiment of the invention said predetermined signal is an electric signal which is capable to initiate a discharging of a capacitor connected to said address electrode and loaded with said first potential.

25   In another embodiment of the invention said time period $\Delta t + \Delta t'$ is shorter than 10ms.

In another embodiment of the invention said time period $\Delta t + \Delta t'$ is shorter than 10µs.

30

In another embodiment of the invention a value of said second potential is essentially equal to half a maximum potential addressed to said address electrode defining an undeflected state at both the maximum and a minimum potential addressed to

4

said address electrode and said third potential is essentially
equal to the minimum potential addressed to said address
electrode.

5   In still another embodiment of the invention said movable
micro-element is supported along a mid-section by a pair of
torsional hinges defining a torsional axis.

In still another embodiment of the invention said movable
10   micro-element is supported along its mid section by a pair of
pivot elements defining a tilting axis and where said restoring
element is at least one flexure hinge capable of restoring said
movable micro-element in an undeflected state but at the same
time permitting said movable micro-element to tilt around said
15   tilting axis.

In still another embodiment, the invention further comprising at
least one flexure hinge capable of restoring said movable
micro-element in a undeflected position but at the same time
20   permitting said movable micro-element to rotate around said
tilting axis.

In still another embodiment of the invention said movable
micro-element is supported along one of its mid sections by a
25   pair of flexure hinges capable of restoring said movable
microelement to a relaxed state but at the same time permitting
said movable micro-element to make an orthogonal movement with
respect to said surface comprising said at least one electrode.

30   In still another embodiment of the invention said movable
micro-element is supported along two of its mid sections by two
pairs of flexure hinges capable of restoring said movable
microelement to a relaxed state but at the same time permitting
said movable micro-element to make an orthogonal movement with
35   respect to said surface comprising said at least one electrode.

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In still another embodiment of the invention said flexure hinges
are attached to the corners of a polygon.

5   In still another embodiment of the invention said flexure hinges
are attached to the sides of a polygon.

In still another embodiment of the invention at least one of
said flexure hinges and/or at least one of said torsional axis
10   is meander shaped.

In still another embodiment of the invention said surface
further comprising a counter electrode laterally spaced apart
from said address electrode and where said address electrode
15   and said counter electrode are capable to electrostatically
attract said movable micro-element.

In still another embodiment of the invention said predetermined
pulsed signal is capable to clear out a potential difference
20   between said address electrode and said counter electrode and
thereby restoring said movable micro-element to said non
addressed state.

In still another embodiment of the invention said predetermined
25   pulsed signal is capable to clear out a potential difference
between said address electrode and said counter electrode and
thereby restoring said movable micro-element to an
electrostatically unattracted state.

30   In still another embodiment of the invention said predetermined
signal is electromagnetic radiation directed onto said movable
element.

In still another embodiment of the invention said predetermined
35   signal is an electric signal capable of discharging a capacitor

6

connected to said address electrode and loaded with said first
potential.

In still another embodiment of the invention said predetermined
5   pulsed signal is synchronised with said time period Δt+Δt' so
that the time Δt' is essentially equal to the pulse length of
said predetermined signal

The invention relates also to a spatial light modulator having
10 a plurality of reflecting elements where said reflecting
elements are movable micro-elements according to any one of the
embodiments as described.

In another embodiment of the invention said reflecting elements
15 are set to a potential via a common element pin.

In still another embodiment of the invention said counter
electrodes are set to a potential via a common counter pin.

20 In still another embodiment of the invention all reflecting
elements are in an addressed state for essentially the same
period of time.

The invention relates also to an apparatus for patterning a
25 workpiece arranged at an image plane and sensitive to
electromagnetic radiation.

In a first embodiment, the invention provides a source emitting
electromagnetic radiation directed onto an object plane. A
30 computer controlled reticle comprising a plurality of
reflecting movable micro-elements, adapted to receive said
electromagnetic radiation at said object plane and to relay
said electromagnetic radiation toward said work piece arranged
said image plane, where said computer controlled reticle

                                7

comprising a plurality of reflecting micro-elements
characterized in that said reflecting micro-elements are
movable micro-elements according to any one of the embodiments
as described.

5

The invention relates also to a method of reducing an
imprinting effect of a movable micro-element arranged spaced
apart from a surface, where said surface comprises at least one
electrode.

10

In a first embodiment, the invention comprising the actions of:
        - setting said movable micro-element to a second
          potential defining a non addressed state,
        - addressing an address electrode to a first potential,
15   where address electrode is arranged on said surface
          and capable to electrostatically attract said movable
          micro-element,
        - switching said movable micro-element from said third
          potential to a fourth potential, defining an addressed
20   state, at a time Δt before a predetermined pulsed
          signal is emitted,
        - keepeing said movable micro-element in said addressed
          state for a time period of $\Delta t + \Delta t'$.

25 In another embodiment, the invention further comprising the
    action of:
        - switching said movable micro-element from said third
          potential back to said second potential thereby
          returning to said non addressed state.
30
    In another embodiment, the invention further comprising the
    action of:
    switching said movable micro-element into an electrostatically
    unattracted state after being in said addressed state.

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In another embodiment, the invention further comprising the
action of:
  - clearing out a potential difference between said address
5 electrode and said movable micro-element by means of said
predetermined pulsed signal and thereby restoring said movable
micro-element to said electrostatically unattracted state.

In another embodiment of the invention said predetermined
10 signal is an electromagnetic radiation signal directed onto
said movable micro-element.

In another embodiment of the invention said predetermined
signal is an electric signal capable to initiate a discharging
15 of a capacitor connected to said address electrode and loaded
with said first potential.

In another embodiment of the invention said time period $\Delta t + \Delta t'$
is shorter than 10 ms.
20

In another embodiment of the invention said time period $\Delta t + \Delta t'$
is shorter than 10 μs.

In another embodiment of the invention said second potential is
25 essentially equal to half a maximum potential addressed to said
address electrode defining an undeflected state at both the
maximum and a minimum potential addressed to said address
electrode and said third potential is essentially equal to said
minimum potential addressed to said address electrode.
30

In still another embodiment, the invention further comprising
the action of:
  - supporting said movable micro-element along a mid section by
a pair of torsional hinges defining a torsional axis.

                                        9

In still another embodiment, the invention further comprising
the action of:
- supporting said movable micro-element along its mid section
5   by a pair of pivot elements defining a tilting axis and where
said restoring element is at least one flexure hinge capable of
restoring said movable micro-element in an undeflected state
but at the same time permitting said movable micro-element to
rotate around said tilting axis.
10
In still another embodiment, the invention further comprising
the action of:
        - restoring said movable micro-element with at least one
           flexure hinge.
15
In still another embodiment, the invention further comprising
the action of:
- supporting said movable micro-element along one of its mid
sections by a pair of flexure hinges which are capable of
20   restoring said movable micro-element to a relaxed state but at
the same time permitting said movable micro-element to make an
orthogonal movement with respect to said surface comprising
said at least one electrode.

25   In still another embodiment, the invention further comprising
the action of:
- supporting said movable micro-element along two mid sections
by a pair of flexure hinges capable of restoring said movable
micro-element to a relaxed state but at the same time
30   permitting said movable micro-element to make an orthogonal
movement with respect to said surface comprising said at least
one electrode.
In another embodiment of the invention said flexure hinges are
attached to the corners of a polygon.
35

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In another embodiment of the invention said flexure hinges are
attached to the sides of a polygon.

In still another embodiment, the invention further comprising
5   the action of:
- where at least one of said flexure hinges and/or at least one
of said torsional axis is meander shaped.

In another embodiment of the invention said movable micro-
10   element is a movable micro-element according to any one of the
embodiments as described.

In still another embodiment, the invention further comprising
the action of:
15   - synchronizing said predetermined pulsed signal with said time
period $\Delta t + \Delta t'$ so that the time $\Delta t'$ is essentially equal to the
pulse length of said predetermined signal.

BRIEF DESCRIPTION OF THE DRAWINGS
20

For a more complete understanding of the present invention, and
the advantages thereof, reference is now made to the following
description taken in conjunction with the accompanying drawings,
in which:
25

FIG. 1a shows a first embodiment of a movable micro-element with
reduced imprinting effect according to the invention.

FIG. 1b shows a second embodiment of a movable micro-element
30   with reduced imprinting effect according to the invention.

FIG. 1c shows a third embodiment of a movable micro-element with
reduced imprinting effect according to the invention.

11

FIG. 1d shows a fourth embodiment of a movable micro-element with reduced imprinting effect according to the invention.

FIG. 1e shows a fifth embodiment of a movable micro-element with
5   reduced imprinting effect according to the invention.

FIG. 2 shows a schematic flow diagram of the method of reducing an imprinting effect according to the invention.

10   FIG. 3 shows a schematic diagram of the deflection as a function of potential difference between an address electrode and a movable micro-element.

FIG. 4 shows an optical system for patterning a substrate coated
15   with a layer of electromagnetic radiation sensitive material.

FIG. 5 illustrates the arrangement of SLM stamps on the workpiece.

20   DETAILED DESCRIPTION OF THE PREFFERED EMBODIMENTS

Figure 1a shows a first embodiment of a movable micro-element, for example a micro mechanical element, with reduced imprinting effect according to the invention. Said movable micro-element
25   may for example be a mirror in a Spatial Light Modulator (SLM). Said mirror may be operated in an analog mode to selectively steer the degree of deflection of said mirror element being a function of an electrical input or digital mode representing an ON and OFF state of the mirror element defined by maximum
30   deflection and non deflection. The deflection of the mirror element may be generally linear or nonlinear, as a function of the input signal, depending on how said mirror (movable micro-element) is being mechanically affected.

12

In this embodiment the movable micro-element 10 is a generally
rectangular reflective element supported along one its mid
sections by a pair of torsion hinges 60. The reflective element
may have any form for example polygonal, circular or elliptical.
5   Said hinges define a torsional axis there along. Said torsion
hinges, extends from the movable micro-element 10 and is
supported by a support element 50. The support element is
supported upon a substrate 20. The movable micro-element 10, the
torsion hinge 60, the support element 50 and the substrate may
10 be of the same material for example silicon or aluminum and they
may be etched out of one substrate using well known etching
techniques for a person skilled in the art and therefore does
not need to be further described.

15 The substrate also comprises an electrically conducting address
electrode 40 and an optional electrically conducting counter
electrode 30. The address electrode 40 and the optional counter
electrode 30 are connected to underlining address circuitry
fabricated within the substrate 20 (not shown). The address
20 electrodes are connected to capacitors, which store the address
voltage addressed to said electrode. The optional counter
electrode 30 and the address electrode 40 are laterally spaced
apart on said surface 20 and capable to electrostatically
attract said movable micro-element 10. The torsion hinge 60,
25 rotate or twist with the movable micro-element 10 and provide
restoring force in the form of mechanical energy. When no
voltage is applied on the movable micro-element, the optional
counter electrode 30 and the addressing electrode the movable
micro-element is said to be in a normal flat or undeflected
30 position which herein below will be referred to as an
electrically unattracted state. By shifting the address voltage
from said address electrode to the counter electrode said
movable micro-element can by rotated in an opposite direction.

13

Figure 1b shows a second embodiment of a movable micro-element
with reduced imprinting effect according to the invention. This
second embodiment comprises in addition to the first embodiment
two flexible hinges 70 connected to the movable micro-element 10
5　　　and supported by a support elements 50. Said flexible hinges 70
also provide restoring forces, and deform or flex, when the
movable micro-element 10 deflects about the torsional axis
defined by the torsion hinges 60. In this embodiment the
flexible hinges 70 are L-shaped with one of its ends connected
10　　　to the support elements 50 and another end connected to the
movable micro-element 10. One of the flexible hinges is
connected at the same side as one of the torsional hinges and
the other flexible hinge is connected at the same side as the
other torsion hinge and the flexible hinges are diagonally
15　　　spaced apart on the movable micro-element.

Figure 1c shows a third embodiment of a movable micro-element
with reduced imprinting effect according to the invention. This
embodiment differs from the second embodiment in that the
20　　　movable micro-element 10 comprises two pivots 65 instead of said
torsion hinges 60. The pivots are supported by said support
elements 50. Said pivots are lying in a recess 55 formed on top
of said support 50 and adapted to the size of the pivot 65 in
order to allow said movable micro-element 20 only to tilt around
25　　　its tilting axis and not to move out sideways of its position.

Restoring forces are provided by flexible hinges 70 which deform
or flex when the movable micro-element 10 deflects about the
tilting axis defined by the pivots 60. In this embodiment the
30　　　flexible hinges 70 are L-shaped with one of its ends connected
to support elements 50 and another end connected to the movable
micro-element 10. One of the flexible hinges is connected at the
same side as one of the pivots and the other flexible hinge is
connected at the same side as the other pivots and the flexible
35　　　hinges are diagonally spaced apart on the movable micro-element.

14

　　　　Figure 1d shows a fourth embodiment of a movable micro-element
　　　　with reduced imprinting effect according to the invention. This
　　　　fourth embodiment differs from the previous embodiments as
5　　　described in connection with figures 1-3 in that a movable
　　　　micro-element 10 moves up and down in a direction perpendicular
　　　　to a surface 20 on which at least one address electrode 40 is
　　　　attached. Flexible hinges 70 are connected to the movable micro-
　　　　element 10 and supported by support elements 50. Said flexible
10　　　hinges 70 provide restoring forces, and deform or flex, when the
　　　　movable micro-element 10 moves up and down in a direction
　　　　essentially orthogonal to the surface 20. In this embodiment the
　　　　flexible hinges 70 are rectangular with one of its ends
　　　　connected to the support elements 50 and another end connected
15　　　to the movable micro-element 10. The flexible hinges are
　　　　attached to the rectangular movable micro-element on two
　　　　opposite sides. Preferably said hinges coincide with one of the
　　　　symmetry axis of said movable micro-element 10. In another
　　　　embodiment at least another pair of flexible hinges 70 are
20　　　attached to said movable micro-element 10 which coincide with
　　　　another symmetry axis of said movable micro-element 10. In the
　　　　embodiment in figure 1d the address electrode 40 is essentially
　　　　of the same size and shape as the movable micro-element 10,
　　　　alternatively both the shape and size of said address electrode
25　　　40 may be different to said movable micro-element 10. Said
　　　　address electrode may also be split into a plurality of address
　　　　electrodes 40. Destructive interference is achieved by shifting
　　　　a movable micro-element 10 downwards (for one quarter of the
　　　　wavelength used to impinge on said element) while another
30　　　movable micro-element (in the same pixel) remains in a relaxed
　　　　position (no electrostatically attraction force between the
　　　　movable micro-element 10 and the address electrode 40).

　　　　Figure 1e shows a fifth embodiment of a movable micro-element
35　　　with reduced imprinting effect according to the invention. This

15

fourth embodiment differs from the fourth embodiment in that the
flexible hinges 70 are L-shaped, the number of flexible elements
70 is four instead of two and in that each pair of them
coincides essentially with a diagonal symmetry axis.

5

Figure 2 shows a schematic flow diagram of the method of
reducing an imprinting effect according to the invention.

10   A first action 110 represents setting said movable micro-element
10 to a second potential. Said second potential may for example
be a potential which is half the value of a maximum potential
addressed to the address electrode. The third potential defining
a non addressed state.

15

A second action 120 represents addressing an address electrode
40 to a first potential. Said first potential may be any value
between a minimum potential and the maximum potential, where
said minimum potential may a ground potential and said maximum
20   potential may for example be 20 V. Said address electrode 40 is
arranged on the surface 20 and capable to electrostatically
attract said movable micro-element 10.

A third action 130 represents switching said movable micro-
25   element from said second potential to a third potential, which
defines an addressed state. The switching to said third
potential takes place a time Δt before a predetermined pulsed
signal is emitted. The third potential may for example be
ground.

30

A fourth action 140 represents keeping the movable micro-element
in said addressed state for a time period equal to $\Delta t + \Delta t'$, which
in one embodiment is shorter than 10ms and in another embodiment
shorter than 10µs. $\Delta t'$ may for instance correspond to the time

16

period for discharging a capacitor which will be a few µs or
shorter depending of the type and size of the capacitor. Δt can
be set at any value in a sub second range, more preferably,
approximately below 10ms, and most preferably below 10µs. Δt is

5   typically longer than $\Delta t'$ but the reverse may be applicable. The
predetermined signal may for instance be a beam of a pulsed
electromagnetical radiation such as for example a pulsed laser.
$\Delta t'$ is in one embodiment synchronized with the pulse length of
the pulsed signal.

10

After being in said addressed state for the time period of
$\Delta t + \Delta t'$ the movable microelement is either switched back to the
second potential or switched to an electrostatically unattracted
state.

15

A Spatial Light Modulator may comprise a plurality of mirrors
which may be of the type of movable micro-elements arranged in a
one-dimensional row or a two dimensional array. In said SLM may
all movable micro-element, i.e. mirror surfaces, be connected

20   together to one voltage plane and it is possible to address this
plane at one of the input pins, a so-called element pin. The
same applies for all counter electrodes 30 on said substrate 20,
i.e. they are jointly addressable using a so-called counter pin.
When the counter electrode 30 is kept at the ground potential,

25   the address electrode is addressed to ground potential and the
movable micro-element is set either to the third or fourth
potential the movable micro-element is not deflected since the
potential difference between the address electrode and the
movable micro-element is equal to the potential difference

30   between the counter electrode and the movable micro-element.
Depending on the thickness there may however be a small bending
downwards in both edges of the movable micro-element. Said
bending will increase with increased voltage applied on said
movable micro-element for a constant thickness of the movable

micro-element. All mirrors in the SLM are switched essentially
at the same time from said third potential to said fourth
potential, i.e. from said non addressed state to said addressed
state. All mirrors in the SLM are also in said addressed state
5   essentially the same period of time ($\Delta t+\Delta t'$) thereby eliminating
or at least reducing the imprinting effect of the mirror
elements. The shorter the time period the mirror elements are in
the addressed state the less the mirror elements will be
affected by the hysteresis effect (imprinting effect), i.e. a
10 shorter duty-cycle, defined as the percentage of time the mirror
elements are in an addressed state, will result in less affected
mirror elements by said hysteresis effect. The mirror elements
are not only in said addressed state for a short time but each
and every mirror element are in said addressed state essentially
15 the same time period namely $\Delta t+\Delta t'$.

If the movable micro-element is set at 10 V and the counter
electrode is kept at ground potential the movable micro-element
10 will remain essentially undeflected both for the case that
20 the address electrode is addressed to the minimum voltage 0 V
and maximum voltage 20 V. This can be understood by realizing
that the sign of the voltage is of no importance for the
electrostatic force, it is always attractive. An example of the
deflection as a function of the potential difference between the
25 address electrode and the movable micro-element is shown in
figure 3. In figure 3 the movable element is at zero potential
and the potential on the address electrode is varying while
measuring the degree of deflection alternative up and down
movement. In this figure one can see that the movable micro-
30 element is essentially undeflected below a certain potential
difference, in this case 10 V. The electrostatic force between
the movable micro-element and the address electrode is
counteracted by the mechanical restoring force in the torsional
hinge(s) 60 and/or the flexible hinge 70. Depending on the type

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and number of torsional hinges and/or flexible hinges attached
to the movable micro-element said deflection as a function of
the potential difference between the address electrode and the
movable micro-element may change.

5

This means that it is possible to address all pixels, i.e.
rotating elements, without essentially deflecting the
corresponding rotating element using 10 V on the rotating
elements. When the voltage on the movable micro-elements is
10   shifted to 0 V just before a predetermined signal, which may for
example be said electromagnetic radiation signal directed onto
said movable micro-element, then all movable micro-elements will
take the desired deflection simultaneously. When the
electromagnetic radiation impinges on the movable micro-element
15   all capacitors connected to the address electrodes on the
substrate will be discharged and the movable micro-elements will
immediately return to the undeflected and electrostatically
unattracted state. In this way the duty-cycle for deflecting any
movable micro-element can be kept very small depending on the
20   switch time of the mirror voltage. If $\Delta t \cdot \Delta t'$ is kept at 10
microseconds, then the duty-cycle for fully deflected state will
be 1% if a frequency of the pulsed signal is 1000 Hz.

When the address electrode is addressed to the maximum or
25   minimum (ground) potential and the movable micro-element is set
to half the value of the maximum potential and the counter
electrode is kept at ground potential the movable micro-element
is undeflected and unaddressed. For each value between said
maximum and minimum potential said movable micro-element will be
30   deflected and unaddressed. The worst case is an address voltage
being half the value of the maximum value. In this case there is
no force between the address electrode and the movable micro-
element since they are both at 10 V. The counter electrode is
then pulling the movable micro-element down with a force
35   corresponding to 10 V. This deflection is fortunately however

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relatively small due to the non-linear behavior of the movable
micro-element as can be seen from figure 3.

Figure 4 shows an embodiment of an apparatus 100 for patterning
5　a work piece 60 coated with a layer of an electromagnetical
radiation sensitive material. Said apparatus 100 comprises a
source 11 for emitting electromagnetic radiation, a first lens
arrangement 50, a computer controlled reticle 30, a second lens
arrangement 20, a spatial filter 70, a third lens arrangement 40
10　and a work piece 60.

The source 11 may emit radiation in the range of wavelengths
from infrared (IR), which is defined as 780 nm up to about 20
μm, to extreme ultraviolet (EUV), which in this application is
15　defined as the range from 100nm and down as far as the radiation
is possible to be treated as electromagnetic radiation. The
source 11 emits radiation either pulsed or continuously. The
emitted radiation from the continuous radiation source 11 can be
formed into a pulsed radiation by means of a shutter located in
20　the radiation path between said radiation source 11 and said
computer controlled reticle 30. As an example can the radiation
source 11 be a KrF excimer laser with a pulsed output at 248 nm,
a pulse length of approximately 10 ns and a repetition rate of
1000 Hz. The repetition rate may be below or above 1000 Hz.
25　The second lens arrangement 20 may be a simple lens or an
assembly of lenses. The second lens arrangement 20 distributes
the radiation emitted from the radiation source 11 uniformly
over a surface of the computer controlled reticle 30.

30　The second lens arrangement 20 may have its exit pupil at
infinity, which means that　central axis of cones of radiation
are parallel. Said object plane coincides with the position of
the computer-controlled reticle 30 and in this embodiment said
central axis of cones of radiation are parallel in said object
35　plane. The computer-controlled reticle 30 may be a Spatial Light

20

Modulator (SLM). In this embodiment the SLM comprises all
information at a single moment that is required to pattern the
whole workpiece 60.

5   Spatial light modulators 30 may be based on reflection or
transmission. In the embodiment as shown in figure 1 the SLM is
a reflective SLM. Reflective Spatial Light modulators come in
two varieties, the deflection type and the phase type. The
differences between them may in a particular case with
10   micromirrors seem small, but the phase SLM extinguishes the beam
in the specular direction by destructive interference, while a
pixel in a deflection SLM deflects the specular beam
geometrically to one side so that it misses the aperture of the
imaging lens. Typically, the micromirrors in a deflection SLM
15   move more out of a flat position defined by the surface of a
relaxed SLM, where the surface of the micromirrors is flat,
compared to the micromirrors in a phase SLM. For ultra precise
patterning as performed in the current invention the phase SLM
is superior to the deflecting type.
20

First, it has better contrast since all parts of the surface,
also hinges and support posts, take part in the destructive
interference and total extinction can be achieved.

25   Second, a system that works by deflecting the radiation to the
side is difficult to make symmetric around an optical axis at
intermediate deflection angles, creating a risk of feature
instability when focus is changed. The phase SLM can be built
with micro machined mirrors, so called micromirrors, or with a
30   continuous mirror surface on a supporting substrate, where said
mirror surface is possible to deform by using an electronic
signal.

For example, said continuous mirror may use a visco elastic
35   layer controlled by an electrostatic field, but it is equally

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possible, especially for very short wavelengths where
deformations of the order of a few nanometers are sufficient, to
use a piezoelectric solid disk that is deformed by electric
field or another electrically, magnetically or thermally
5   controlled reflecting surface. For the remainder of this
application an electrostatically controlled micro-mirror matrix
(one- or two dimensional) is assumed, although other
arrangements as described above are possible, such as
transmissive or reflective SLMs relying on LCD crystals or
10   electro optical materials as their modulation mechanism, or
micro-mechanical SLMs using piezoelectric or electrostrictive
actuation.

The SLM is a programmable device that produces an output
15   radiation beam that is modulated by separate inputs from a
computer. The SLM simulates the function of a mask through the
generation of bright and dark pixels in response to computer fed
data. For example the phase SLM is an array of etched solid-
state mirrors. Each micro-mirror element is suspended above a
20   silicon substrate by torsion hinges, which may be supported
either by separate support posts or by the adjacent mirrors.
Beneath the micro-mirror element are address electrodes. One
micro-mirror represents one pixel in the object plane. The pixel
in the image plane is here defined as to have the same geometry
25   as the micro-mirror but the size may be different due to the
optics, i.e. larger or smaller depending on if the optics is
magnifying or de-magnifying.

The micro-mirror and the address electrodes act as a capacitor
30   so that a voltage applied to the address electrode, with respect
to a voltage to the micro-mirror, will twist the torsion hinges
suspending the micro-mirror which in turn allow the micro-mirror
to rotate, thereby creating a phase difference. Depending on the
voltage applied the rotation of the micro-mirror may take any
35   state between flat to fully rotated position. A fully rotated

22

micro mirror having an essentially square surface with its sides
approximately 16μm long is typically 8mRad. More generally the
fully rotated micro-mirror will rotate one quarter of the
wavelength used, measured at the edges parallel to the rotation
5   axis or with micromirrors with orthogonal movement with respect
to the surface the difference between max and min state is one
quarter of the wavelength used, measured parallel with a surface
of said micro-mirror.

10 A projection system 80 comprises in this embodiment the third
lens arrangement 40, a spatial filter 70 and the first lens
arrangement 50. The third lens arrangement 40 and the spatial
filter 70 forms together what is generally called a Fourier
filter.

15

The spatial filter 70 is in this embodiment an aperture in a
plate. Said aperture being sized and positioned so as to block
out essentially every diffraction order which is diffracted into
the first and higher diffraction orders, for example said
20 aperture may be located at the focal distance from the third
lens arrangement 40. The reflected radiation is collected by
said third lens arrangement 40 in the focal plane, which acts at
the same time as a pupil plane of the first lens arrangement 50.
The aperture cuts out the light from the first and higher
25 diffraction orders of the addressed micromirrors in the SLM,
while the radiation from the non-addressed mirror surfaces can
pass the aperture. The result is intensity modulated aerial
image on the work piece 60 as in conventional lithography. For
an optimum image contrast the diffraction pattern of an SLM with
30 all pixels deflected should only contain light in the first and
higher diffraction orders without any radiation in the zeroth
order.

The first lens arrangement 50 has in this embodiment its exit
35 pupil at infinity, i.e. central axis of cones of radiation in a

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image plane defined by the position of the work piece 60 are parallel.

The work piece 60 may be a substrate with a photosensitive

5   surface, such as a photo mask for semiconductor devices and
    display panels. It may also be semi-conducting wafer coated with
    a photosensitive layer. Since the present invention not only
    have applications in direct patterning of semiconductor device
    patterns, display panels, integrated optical devices and

10 electronic interconnect structures, it can also have
    applications to other types of patterning such as security
    patterning. The term patterning should be understood in a broad
    sense, meaning exposure of photo resist and photographic
    emulsion, but also the action of radiation on other radiation

15 sensitive media such as dry process paper, by ablation or
    chemical processes activated by radiation or heat. The present
    invention may also find application in wafer repairing, wherein
    a processed wafer is reprocessed with the radiation beam.

20 The work piece 60 may also rest on a moving stage, which moves
    at a constant velocity. The electromagnetic radiation is in said
    case a pulsed electromagnetic source 11 where each pulse that
    illuminates the computer controlled reticle 30 and is imaged
    onto the work piece 60 will illuminate a different part of the

25 work piece 60. The computer-controlled reticle 30 which for
    example may be a SLM operates so that the entire array of
    micromirrors can be reconfigured for each pulse to form the
    correct image on the work piece 60.

30 At first, binary pattern from a CAD layout is transformed into a
    data set of SLM data. The data is transferred to the SLM, where
    the built in control electronics causes a number of micromirrors
    to change position. Thereby, the non-deflected pixels represent
    bright regions on the work piece. Every cone of radiation in a

35 specific image pixel as defined previously in said image plane

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corresponds to a specific object pixel in said computer
controlled reticle 30, which for example may be a single
micromirror. Each micromirror may be of the type of movable
micro-element as described hereinabove.

5

A pattern on a work piece 60 is created by a number of SLM
stamps. Said stamps may be partially overlapping each other.
Said stamps may be grouped together in strips, where each strip
comprises at least two stamps and covers the full length of a

10   mask substrate or a portion of it. Said stamps in a strip are
arranged in a one-dimensional line, for example a row or a
column of stamps.

Figure 5 illustrates an example of how SLM stamps 150 are

15   arranged on a workpiece 60. In said figure the workpiece 60 is
covered by 8 lines 11, 12, 13, 14, 15, 16, 17, 18 and 8 columns
c1, c2, c3, c4, c5, c6, c7, c8 of SLM stamps 150. In reality a
workpiece is covered with several thousands of SLM stamps but
for reason of clarity only an 8x8 pattern is illustrated. An

20   individual stamp comprises a large number of pixels, typically
in the order of million pixels. A strip may be a complete line
11, 12, 13, 14, 15, 16, 17, 18 or a portion of such a line. A
support structure, which carries the workpiece, is moving along
a direction of a strip, for example along a line 11, 12, 13, 14,

25   15, 16, 17, 18 while the radiation source flashes radiation onto
the SLM for imaging the pattern thereon to the workpiece. After
having finished a strip, the support structure is moved in a
direction essentially perpendicular to the direction of a strip
and a distance essentially equal to a size of a stamp in said

30   direction.

Imprinting is a cumulative material effect, which manifest
itself by a gradually increased change of the actuator/pixel
position when all parameters are kept constant in the deflected

35   state. It further manifests itself by more or less curing out

when the actuator is left in the non-deflected state for a
sufficient amount of time. Both building up imprinting and
curing out imprinting are non-linear effects. The position at a
given time thus depends not only on the electrostatic force the
5   actuator is experiencing at that time, but also on the history
of deflection of this particular actuator. Therefore, the
response of the actuator becomes inaccurate after a given period
of time, i.e. the placement accuracy of features on the mask in
the lithography process is reduced.
10

In another embodiment according to the invention said imprinting
is completely or at least substantially reduced.

During the time period of processing a complete pattern on a
15 workpiece, there may be time intervals, which are longer than
the time between two laser flashes, when no pattern is
generated. During the return stroke, which is the time it takes
for the support structure to move from an end of a finished
strip to a beginning of another strip, the laser does not
20 illuminate the SLM. During the return stroke the pattern on the
SLM is not affecting the final pattern on the mask. It is
therefore possible to operate the SLM in any way desired to
reduce or neutralize the cumulative imprinting effect from
stripe to stripe during the time of a return stroke.
25

When printing a specific pattern on a work piece the time of
deflection and the degree of deflection for each individual
pixel may be monitored during each strip. Counteraction of
imprinting during for example the return stroke can be achieved
30 by shifting each actuator in a reversed or negative state. This
may be done using amplitude and address time, or a set of
amplitudes and address times, individually for each actuator in
the SLM, which exactly inhibits the imprinting induced during
the previous strip(s) exposure(s).
35

                              26

It is further possible to use a feed back system in which the
momentaneous imprinting induced for each actuator is monitored
and thereafter cancelled. This can be done using an in-system
camera based monitor system, where the contrast from each
5   actuator is measured when all actuators are addressed to an
identical amplitude. The measurements should be done immediately
after each strip using a collective address position for the
actuators where the contrast derivative is highest possible in
the mask writer system. The information from this measurement
10 can then be used to fine tune the amplitude and address time for
the imprinting counteraction addressing during the rest of the
return stroke.

Instead of using the return stroke as the time period for
15 reducing or canceling the imprinting effects, said cancellation
or reduction method may be performed at any time in the
processing of a complete pattern. For instance, the imaging
procedure may be stopped at any given time when a particular
actuator has been in the addressed state for a given time
20 period, where the amount of deflection may or may not be taken
into account.

The cancellation of imprinting may be performed in more than one
step. After having counteracted the individual actuators for a
25 given time interval, either calculated from information about
deflecting time and degree of deflection or from a picture taken
by a CCD camera for example, a further fine tuning may be
performed out of a picture taken of the imprinting cancelled
SLM. Every SLM pixel is set to a given state, and the degree of
30 difference from said state give rise to a further fine
adjustment of said actuator or compensation in an addressing
function for the individual pixels.

27

　　　Thus, although there has been disclosed to this point
particular embodiments of the apparatus for patterning a work
piece, it is not intended that such specific references be
considered as limitations upon the scope of this invention
5　　except in-so-far as set forth in the following claims.
Furthermore, having described the invention in connection with
certain specific embodiments thereof, it is to be understood
that further modifications may suggest themselves to those
skilled in the art, it is intended to cover all such
10　　modifications as fall within the scope of the appended claims.

28

CLAIMS

1. A movable micro-element (10) with reduced imprinting effect
   arranged spaced apart from a surface (20) comprising at
5   least one electrode, at least one restoring element (60, 70)
   is connected to said movable micro-element (10), an address
   electrode (40) is arranged on said surface (20) and capable
   to electrostatically attract said movable micro-element (10)
   and where said address electrode (40) is addressed to a
10   first potential, **characterized in that** said movable micro-
   element (10) is first set to a second potential defining a
   non addressed state and at a time period Δt before a
   predetermined pulsed signal is emitted onto said movable
   micro-element (10) is switched from said second potential to
15   a third potential defining an addressed state, where said
   movable micro-element (10) is kept in said addressed state
   for a time period of Δt+Δt'.

2. The movable micro-element (10) according to claim 1, wherein
   said movable micro-element (10) is switched back into said
20   non addressed state after being in said addressed state by
   switching said third potential back to said second
   potential.

3. The movable micro-element (10) according to claim 1, wherein
   said movable micro-element (10) is switched into an
25   electrostatically unattracted state after being in said
   second potential.

4. The movable micro-element (10) according to claim 3, wherein
   said predetermined pulsed signal is capable to clear out a
   potential difference between said address electrode (40) and
30   said movable micro-element (10) and thereby restoring said
   movable micro-element (10) to said electrostatically
   unattracted state.

29

5. The movable micro-element (10) according to claim 1 or 4, wherein said predetermined pulsed signal is electromagnetic radiation directed onto said movable micro-element (10).

6. The movable micro-element (10) according to claim 1 or 4, wherein said predetermined pulsed signal is an electric signal capable to initiate a discharging of a capacitor connected to said address electrode (40) and loaded with said first potential.

7. The movable micro-element (10) according to any one of the preceding claims, wherein said time period $\Delta t + \Delta t'$ is shorter than 10ms.

8. The movable micro-element (10) according to any one of claim 1-6, wherein said time period $\Delta t + \Delta t'$ is shorter than 10µs.

9. The movable micro-element (10) according to claim 1, wherein a value of said second potential is essentially equal to half a maximum potential addressed to said address electrode (40) defining an undeflected state at both the maximum and a minimum potential addressed to said address electrode (40) and said third potential is essentially equal to said minimum potential addressed to said address electrode (40).

10. The movable micro-element (10) according to any one of claim 1-9, wherein said movable micro-element (10) is supported along a mid section by a pair of torsion hinges (60) defining a torsional axis.

11. The movable micro-element (10) according to any one of claim 1-9, wherein said movable micro-element (10) is supported along a mid section by a pair of pivot elements (65) defining a tilting axis and where said restoring element is at least one flexure hinge (70) capable of restoring said movable micro-element (10) in an undeflected state but at the same time permitting said movable micro-element (10) to tilt around said tilting axis.

12. The movable micro-element according to claim 10, further comprising at least one flexure hinge capable of restoring

said movable micro-element in an undeflected state but at
the same time permitting said movable micro-element (10) to
tilt around said tilting or torsional axis.

5   13.   The movable micro-element (10) according to any one of
     claim 1-9, wherein said movable micro-element (10) is
     supported along one of its mid sections by a pair of flexure
     hinges (70) capable of restoring said movable micro-element
     (10) to a relaxed state but at the same time permitting said
     movable micro-element (10) to make an orthogonal movement
10   with respect to said surface (20) comprising said at least
     one electrode.

     14.   The movable micro-element (10) according to any one of
     claim 1-9, wherein said movable micro-element (10) is
     supported along two mid sections by two pairs of flexure
15   hinges (70) capable of restoring said movable micro-element
     (10) to a relaxed state but at the same time permitting said
     movable micro-element (10) to make an orthogonal movement
     with respect to said surface (20) comprising said at least
     one electrode.

20   15.   The movable micro-element (10) according to any one of
     claim 13 or 14, wherein said flexure hinges (70) are
     attached to the corners of a polygon-shaped movable micro-
     element (10).

     16.   The movable micro-element according to any one of claim
25   13 or 14, wherein said flexure hinges (70) are attached to
     the sides of a polygon-shaped movable micro-element (10).

     17.   The movable micro-element (10) according to any one of
     claim 10-16, wherein at least one of said flexure hinges
     (70) and/or at least one of said torsional axis is meander
30   shaped.

     18.   The movable micro-element (10) according to any one of
     claim 1-17, wherein said surface (20) further comprising a
     counter electrode (30) laterally spaced apart from said
     address electrode (40) where said address electrode (40) and

said counter electrode (30) are capable to electrostatically
attract said micro-element (10).

19. The movable micro-element (10) according to claim 18,
wherein said predetermined pulsed signal is capable to clear
5　　out a potential difference between said address electrode
(40) and said counter electrode (30) and thereby restoring
said movable micro-element (10) to said non addressed state.

20. The movable micro-element (10) according to claim 18,
wherein said predetermined pulsed signal is capable to clear
10　　out a potential difference between said address electrode
(40) and said counter electrode (30) and thereby restoring
said movable element (10) to an electrostatically
unattracted state.

21. The movable micro-element (10) according to claim 19-20,
15　　wherein said predetermined pulsed signal is electromagnetic
radiation directed onto said movable element (10).

22. The movable micro-element (10) according to claim 19-20,
wherein said predetermined pulsed signal is an electric
signal capable of discharging a capacitor connected to said
20　　address electrode (40) and loaded with said first potential.

23. The movable micro-element (10) according to claim 1 or
19, wherein said predetermined pulsed signal is synchronized
with said time period $\Delta t + \Delta t'$ so that the time $\Delta t'$ is
essentially equal to the pulse length of said predetermined
25　　pulsed signal.

24. A spatial light modulator having a plurality of
reflecting elements, characterized in that said reflecting
elements are movable micro-elements (10) according to any
one of claims 1-23.

30　　25. The spatial light modulator according to claim 24,
wherein said reflecting elements are set to a potential via
a common element pin.

26. The spatial light modulator according to claim 23 or 24,
wherein said counter electrodes (30) are set to a potential
35　　via a common counter pin.

32

27. The spatial light modulator according to claim 23-26,
    wherein all reflecting elements are in an addressed state
    for essentially the same period of time.

28. An apparatus for patterning a workpiece (60) arranged at
5   an image plane and sensitive to electromagnetic radiation,
    comprising:
    - a source (11) emitting electromagnetic radiation
      directed onto an object plane,
    - a computer controlled reticle (30) comprising a
10   plurality of reflecting elements, adapted to receive
      said electromagnetic radiation at said object plane
      and to relay said electromagnetic radiation toward
      said work piece (60) arranged at said image plane,
      where said computer controlled reticle (30) comprising
15   a plurality of reflecting elements **characterized in**
      that said reflecting elements are movable micro-
      elements according to any one of claims 1-23.

29. A method of reducing an imprinting effect of a movable
20 micro-element arranged spaced apart from a surface, where
    said surface comprises at least one electrode, comprising
    the actions of:
    - setting said movable micro-element to a second
      potential defining a non addressed state,
25 - addressing an address electrode to a first potential,
      where said address electrode is arranged on said
      surface and capable to electrostatically attract said
      movable micro-element,
    - switching said movable micro-element from said second
30   potential to a third potential, defining an addressed
      state, at a time Δt before a predetermined pulsed
      signal is emitted.
    - keeping said movable micro-element in said addressed
      state for a time period $\Delta t + \Delta t'$.

30.   The method according to claim 29, further comprising the
   action of:
- switching said micro-element from said third potential back
to said second potential thereby returning to said non-
addressed state.
31.   The method according to claim 29, further comprising the
   action of:
- switching said movable micro-element into an
electrostatically unattracted state after being in said
addressed state.
32.   The method according to claim 31, further comprising the
   action of:
- clearing out a potential difference between said address
electrode and said movable micromirror by means of said
predetermined pulsed signal and thereby restoring said movable
element to said electrostatically unattracted state.
33.   The method according to claim 29-32, wherein said
   predetermined pulsed signal is an electromagnetic radiation
   signal directed onto said movable micro-element.
34.   The method according to claim 29-32, wherein said
   predetermined pulsed signal is an electric signal capable to
   initiate a discharging of a capacitor connected to said
   address electrode and loaded with said first potential.
35.   The method according to any one of claim 29-34, wherein
   said time period $\Delta t + \Delta t'$ is shorter than 10ms.
36.   The method according to any one of claim 29-34, wherein
   said time period $\Delta t + \Delta t'$ is shorter than 10μs.
37.   The method according to any one of claim 29-36, wherein a
   value of said second potential is essentially equal to half
   a maximum potential addressed to said address electrode
   defining an undeflected state at both the maximum and a
   minimum potential addressed to said address electrode and

said third potential is essentially equal to said minimum
potential addressed to said address electrode.

38.   The method according to any one of claim 29-37, further
comprising the action of:

5   - supporting said movable micro-element along a mid section by
a pair of torsion hinges defining a torsional axis.

39.   The method according to any one of claim 29-37, further
comprising the action of:

- supporting said movable micro-element along its mid section

10   by a pair of pivot element defining a tilting axis and where
said restoring element is at least one flexure hinge capable of
restoring said movable micro-element in an undeflected state
but at the same time permitting said movable micro-element to
tilt around said tilting axis.

15   40.   The method according to any one of claim 38-39, further
comprising the action of:

        - restoring said movable micro-element with at least one
          flexure hinge.

41.   The method according to any one of claim 29-37, further

20   comprising the action of:

        - supporting said movable micro-element along one of its
          mid sections by a pair of flexure hinges which are
          capable of restoring said movable micro-element to a
          relaxed state but at the same time permitting said

25   movable micro-element to make an orthogonal movement
          with respect to said surface comprising said at least
          one electrode.

42.   The method according to any one of claim 29-37, further
comprising the action of:

30   - supporting said movable micro-element along two mid sections
by a pair of flexure hinges capable of restoring said movable
micro-element to a relaxed state but at the same time
permitting said movable micro-element to make an orthogonal
movement with respect to said surface comprising said at least

35   one electrode.

43.   The method according to any one of claim 41-42, wherein
       said flexure hinges are attached to the corners of a
       polygon.
44.   The method according to any one of claim 41-42, wherein
 5   said flexure hinges are attached to the sides of a polygon.
45.   The method according to any one of claim 38-44, wherein
       at least one of said flexure hinges and/or at least one of
       said torsional axis is meander shaped.
46.   The method according to any one of claim 29-45, where
10   said movable micro-element is a movable micro-element
       according to any one of claim 1-23.
47.   The method according to any one of claim 29-46 further
       comprising the action of:
         · synchronizing said predetermined pulsed signal with
15   said time period $\Delta t + \Delta t'$ so that the time $\Delta t'$ is
           essentially equal to the pulse length of said
           predetermined signal.
48.   The method according to claim 29, further comprising the
       action of:
20   - neutralizing cumulated imprinting effects while
           prohibiting said pulsed signal to reach said movable
           micro elements.
49.   The method according to claim 48, wherein said
       neutralizing action is performed by deflecting individual
25   movable micro element in a reverse direction compared to the
       way they are deflected during intended operation.
50.   The method according to claim 49, wherein individual
       movable micro elements are deflected in a first direction a
       given time and a given degree of deflection depending on the
30   cumulated time and degree of deflection in a second
       deflection direction.
51.   The method according to claim 48, wherein said
       neutralizing of said cumulated imprinting effects are
       performed between different strips building up a complete
35   pattern on a workpiece.

36

52.　　The method according to claim 48, wherein said
    neutralizing of said cumulated imprinting effects is
    performed after at least one movable micro element has been
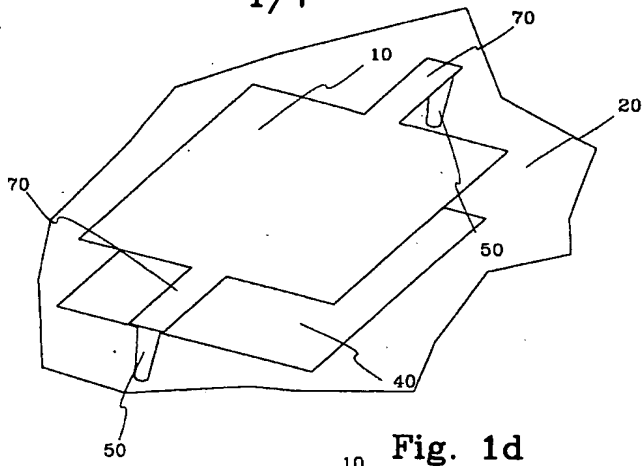   deflected a predetermined cumulated time period.
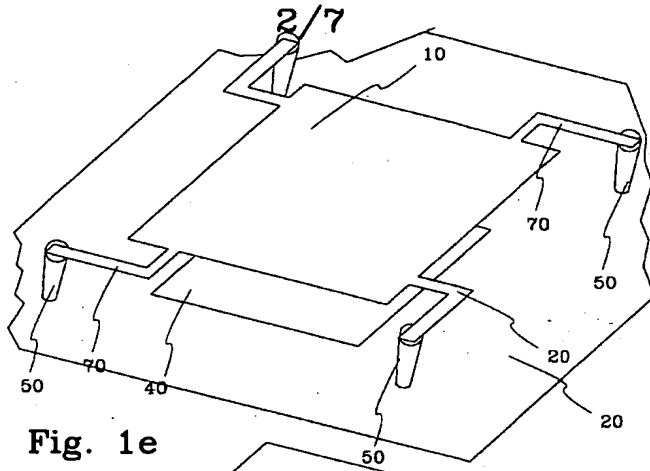
5

1/7

Fig. 1d

Fig. 1a

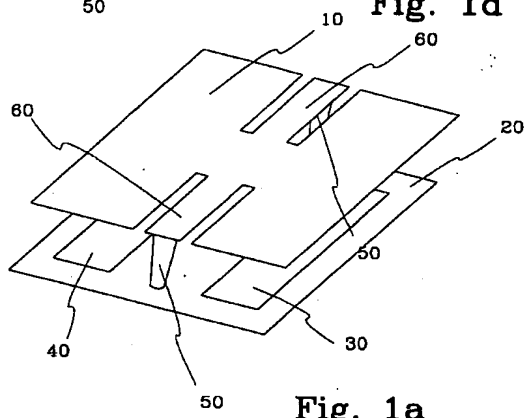2/7

Fig. 1e

Fig. 1b

3/7

Fig. 1c

4/7

Fig. 2

5/7

Fig. 3

6/7
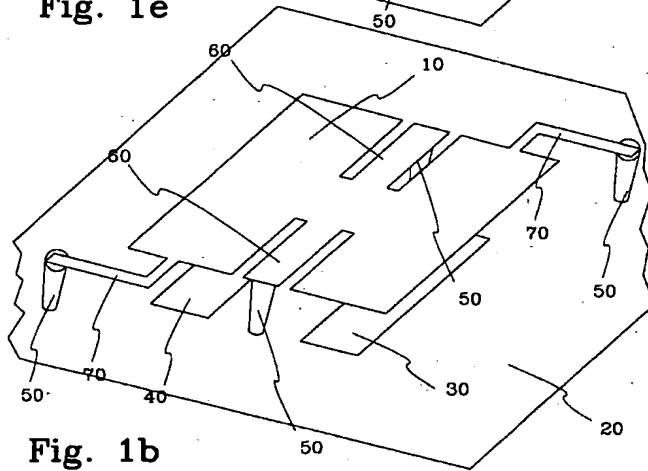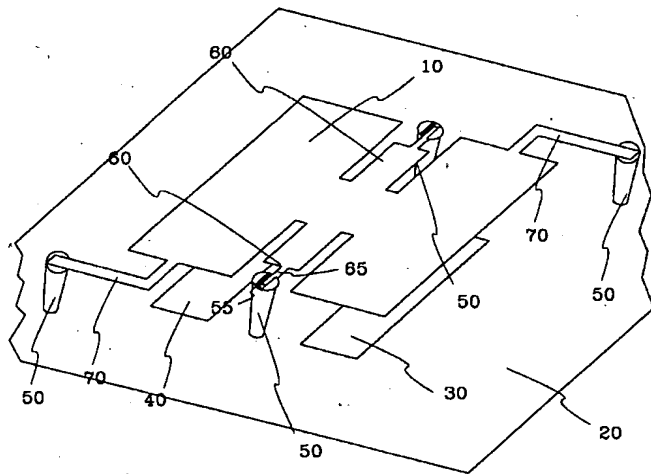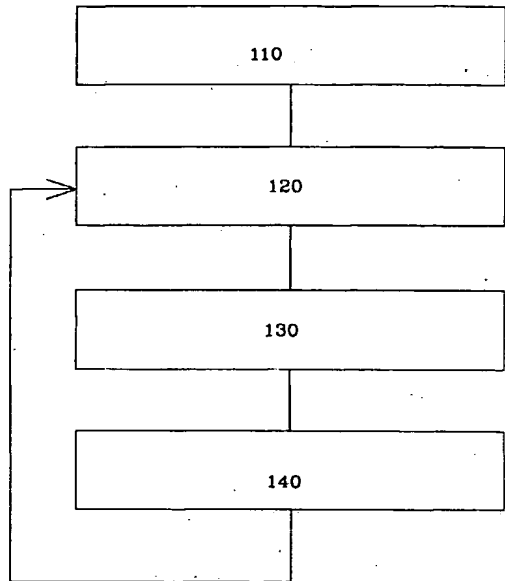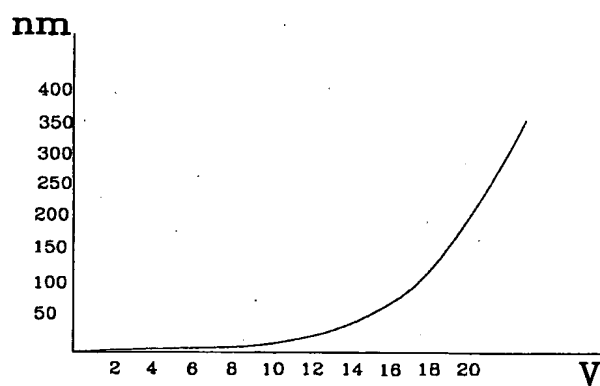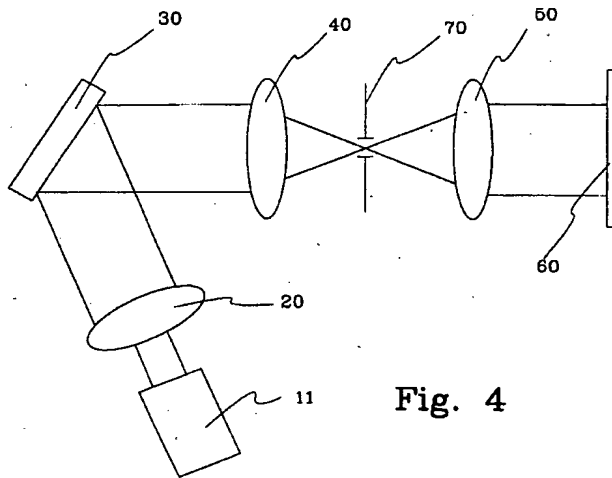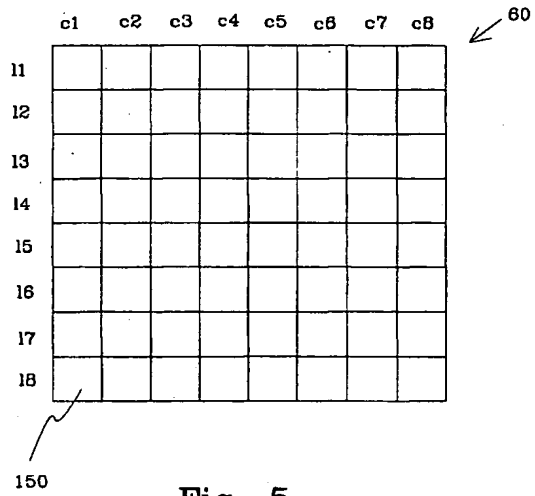

Fig. 4

7/7

Fig. 5

【手続補正書】
【提出日】平成15年8月4日（2003.8.4）
【手続補正1】
【補正対象書類名】特許請求の範囲
【補正対象項目名】全文
【補正方法】変更
【補正の内容】
【特許請求の範囲】
【請求項1】
少なくとも１つの電極を有する表面（２０）から離間して配置されて、履歴効果の少ない、可動マイクロ素子（１０）であって、前記可動マイクロ素子（１０）には、少なくとも１つの復帰部材（６０，７０）が接続され、前記表面（２０）上にはアドレス電極（４０）が配設され、前記可動マイクロ素子（１０）を静電吸引可能であり、前記アドレス電極（４０）が、第１電位にアドレスされるものにおいて、
前記可動マイクロ素子（１０）は、先ず、所定のパルス信号が前記可動マイクロ素子（１０）に対して発信される前の時間Δｔにおいて、非アドレス状態を形成する第２電位に設定され、前記可動部材は、前記第２電位から、アドレス状態を形成する第３電位に切り替えられ、前記履歴作用は、前記可動マイクロ素子（１０）のアドレス状態デューティーサイクルを減少させることによって低減される可動マイクロ素子（１０）。
【請求項2】
請求項１の可動マイクロ素子（１０）であって、前記可動マイクロ素子（１０）は、前記第３電位を前記第２電位へ戻すことによって、前記アドレス状態後に、前記非アドレス状態に戻される可動マイクロ素子（１０）。
【請求項3】
請求項１の可動マイクロ素子（１０）であって、前記可動マイクロ素子（１０）は、前記第２電位状態後に、静電非吸引状態に切り替えられる可動マイクロ素子（１０）。
【請求項4】
請求項３の可動マイクロ素子（１０）であって、前記所定パルス信号は、前記アドレス電極（４０）と、前記可動マイクロ素子（１０）との間の電位差をクリア可能であり、これにより、前記可動マイクロ素子（１０）を前記静電非吸引状態に復帰させる可動マイクロ素子（１０）。
【請求項5】
請求項１又は４の可動マイクロ素子（１０）であって、前記所定パルス信号は、前記可動マイクロ素子（１０）に向けられる電磁放射である可動マイクロ素子（１０）。
【請求項6】
請求項１又は４の可動マイクロ素子（１０）であって、前記所定パルス信号は、前記アドレス電極（４０）に接続されるとともに、前記第１電位をローディングされるコンデンサの放電を開始させることが可能な電気信号である可動マイクロ素子（１０）。
【請求項7】
請求項１の可動マイクロ素子（１０）であって、前記可動マイクロ素子は、１０ｍｓよりも短い時間Δｔ＋Δｔ’、前記アドレス状態に維持される可動マイクロ素子（１０）。
【請求項8】
請求項１の可動マイクロ素子（１０）であって、前記可動マイクロ素子は、１０μｓよりも短い時間Δｔ＋Δｔ’、前記アドレス状態に維持される可動マイクロ素子（１０）。
【請求項9】
請求項１の可動マイクロ素子（１０）であって、前記第２電位の値は、前記アドレス電極（４０）に対してアドレスされる最大電位と最小電位との両方において非偏向状態を形成する、前記アドレス電極（４０）に対してアドレスされる最大電位の半分に実質的に等しく、前記第３電位は、前記アドレス電極（４０）に対してアドレスされる前記最小電位に実質的に等しい可動マイクロ素子（１０）。

【請求項１０】
請求項１～９のいずれかの可動マイクロ素子（１０）であって、前記可動マイクロ素子（
１０）は、その中間部分に沿って、捻れ軸心を形成する一対の捻りヒンジ（６０）によっ
て支持されている可動マイクロ素子（１０）。

【請求項１１】
請求項１～９のいずれかの可動マイクロ素子（１０）であって、前記可動マイクロ素子（
１０）は、その中間部分に沿って、傾動軸心を形成する一対の回動部材（６５）によって
支持され、前記復帰部材は、非偏向状態において前記可動マイクロ素子（１０）を復帰さ
せるとともに、これと同時に、前記可動マイクロ素子（１０）が前記傾動軸心回りで傾動
することを許容することが可能な少なくとも１つの屈曲ヒンジ（７０）である可動マイク
ロ素子（１０）。

【請求項１２】
請求項１０の可動マイクロ素子（１０）であって、更に、非偏向状態において前記可動マ
イクロ素子を復帰させるとともに、これと同時に、前記可動マイクロ素子（１０）が前記
傾動軸心または前記捻れ軸心回りで傾動することを許容することが可能な少なくとも１つ
の屈曲ヒンジを有する可動マイクロ素子（１０）。

【請求項１３】
請求項１～９のいずれかの可動マイクロ素子（１０）であって、前記可動マイクロ素子（
１０）は、その中間部分の１つに沿って、前記可動マイクロ素子（１０）を弛緩状態へ復
帰させるとともに、これと同時に、前記可動マイクロ素子（１０）が前記少なくとも１つ
の電極を有する前記表面（２０）に対して垂直移動することを許容することが可能な一対
の屈曲ヒンジ（７０）によって支持されている可動マイクロ素子（１０）。

【請求項１４】
請求項１～９のいずれかの可動マイクロ素子（１０）であって、前記可動マイクロ素子（
１０）は、その中間部分の二つに沿って、前記可動マイクロ素子（１０）を弛緩状態に復
帰させるとともに、これと同時に、前記可動マイクロ素子（１０）が、前記少なくとも１
つの電極を有する前記表面（２０）に対して垂直移動することを許容することが可能な二
対の屈曲ヒンジ（７０）によって支持されている可動マイクロ素子（１０）。

【請求項１５】
請求項１３又は１４のいずれかの可動マイクロ素子（１０）であって、前記屈曲ヒンジ（
７０）は、多角形状の可動マイクロ素子（１０）の角部に取り付けられている可動マイク
ロ素子（１０）。

【請求項１６】
請求項１３又は１４のいずれかの可動マイクロ素子（１０）であって、前前記屈曲ヒンジ
（７０）は、多角形状の可動マイクロ素子（１０）の面部に取り付けられている可動マイ
クロ素子（１０）。

【請求項１７】
請求項１０～１６のいずれかの可動マイクロ素子（１０）であって、前記屈曲ヒンジ（７
０）の少なくとも１つおよび／又は前記捻れ軸心の少なくとも１つは、曲折形状である可
動マイクロ素子（１０）。

【請求項１８】
請求項１～１７のいずれかの可動マイクロ素子（１０）であって、前記表面（２０）は、
更に、前記アドレス電極（４０）から側方に離間した対向電極（３０）を有し、前記アド
レス電極（４０）と前記対向電極（３０）とは、前記可動マイクロ素子（１０）を静電吸
引可能である可動マイクロ素子（１０）。

【請求項１９】
請求項１８の可動マイクロ素子（１０）であって、前記所定パルス信号は、前記アドレス
電極（４０）と前記対向電極（３０）との間の電位差をクリア可能であり、これによって
、前記可動マイクロ素子（１０）を前記非アドレス状態へ復帰させる可動マイクロ素子（
１０）。

【請求項２０】
請求項１８の可動マイクロ素子（１０）であって、前記所定パルス信号は、前記アドレス
電極（４０）と前記対向電極（３０）との間の電位差をクリア可能であり、これによって
、前記可動マイクロ素子（１０）を静電非吸引状態へ復帰させる可動マイクロ素子（１０
）。

【請求項２１】
請求項１９～２０の可動マイクロ素子（１０）であって、前記所定パルス信号は、前記可
動マイクロ素子（１０）に向けられる電磁放射である可動マイクロ素子（１０）。

【請求項２２】
請求項１９～２０の可動マイクロ素子（１０）であって、前記所定パルス信号は、前記ア
ドレス電極（４０）に接続されるとともに、前記第１電位をローディングされるコンデン
サの放電をすることが可能な電気信号である可動マイクロ素子（１０）。

【請求項２３】
請求項７又は８の可動マイクロ素子（１０）であって、前記所定パルス信号は、前記時間
Δｔ’が、前記所定信号のパルス長と実質的に等しくなるように、前記時間Δｔ＋Δｔ’
と同期される可動マイクロ素子（１０）。

【請求項２４】
複数の反射部材を備える空間光変調器であって、前記反射部材が、請求項１～２３のいず
れかの可動マイクロ素子（１０）であることを特徴とする空間光変調器。

【請求項２５】
請求項２４の空間光変調器であって、前記反射部材は、１つの共通の素子ピンを介して１
つの電位に設定される空間光変調器。

【請求項２６】
請求項２３又は２４の空間光変調器であって、前記対向電極（３０）は、１つの共通の対
向ピンを介して１つの電位に設定される空間光変調器。

【請求項２７】
請求項２３～２６の空間光変調器であって、前記反射部材は、すべて、実質的に同じ時間
、アドレス状態にされる空間光変調器。

【請求項２８】
結像面に配置され、電磁放射に感応する加工物（６０）をパターニングするための装置で
あって、以下、
対物面に向けて電磁放射を放出するソース（１１）と、
前記対物面において前記電磁放射を受け、この電磁放射を前記結像面に配置された前記加
工物（６０）に向けて中継するように構成された、複数の反射素子を有するコンピュータ
制御焦点板（３０）とを有し、
ここで、前記コンピュータ制御焦点板（３０）が複数の反射部材を有するものにおいて、
前記反射部材は、請求項１～２３のいずれかの可動マイクロ素子であることを特徴とする
装置。

【請求項２９】
表面から離間して配置された可動マイクロ素子の履歴効果を低減させるための方法であっ
て、ここで前記表面が、少なくとも１つの電極を有するものにおいて、前記方法は以下の
工程：
前記可動マイクロ素子を、非アドレス状態を形成する第２電位に設定する工程と、
アドレス電極を第１電位にアドレスする工程であって、ここでアドレス電極は、前記表面
上に配置され、前記可動マイクロ素子を静電吸引可能である工程と、
前記可動マイクロ素子を、所定のパルス信号が発信される前の時間Δｔにおいて、前記第
２電位から、アドレス状態を形成する第３電位に切り替える工程と、
前記可動マイクロ素子のアドレス状態デューティーサイクルを減少させることによって前
記履歴作用を減少させる工程と
を包含する方法。

【請求項３０】
請求項２９の方法であって、更に、以下の工程：
前記第３電位から前記第２電位へ前記可動マイクロ素子を切り替えることによって、前記非アドレス状態に戻す工程を包含する方法。
【請求項３１】
請求項２９の方法であって、更に以下の工程：
前記可動マイクロ素子を、前記アドレス状態後に、静電非吸引状態に切り替える工程を包含する方法。
【請求項３２】
請求項３１の方法であって、更に以下の工程：
前記所定パルス信号によって、前記アドレス電極と、前記可動マイクロミラーとの間の電位差をクリアし、これにより、前記可動マイクロ素子を前記静電非吸引状態に復帰させる工程を包含する方法。
【請求項３３】
請求項２９～３２のいずれかの方法であって、前記所定パルス信号は、前記可動マイクロ素子に向けられる電磁放射信号である方法。
【請求項３４】
請求項２９～３２のいずれかの方法であって、前記所定パルス信号は、前記アドレス電極に接続されるとともに、前記第１電位をローディングされるコンデンサの放電を開始させることが可能な電気信号である方法。
【請求項３５】
請求項２９～３４のいずれかの方法であって、前記可動マイクロ素子は、１０ｍｓよりも短い時間Δｔ＋Δｔ’、前記アドレス状態に維持される方法。
【請求項３６】
請求項２９～３４のいずれかの方法であって、前記可動マイクロ素子は、１０μｓよりも短い時間Δｔ＋Δｔ’、前記アドレス状態に維持される方法。
【請求項３７】
請求項２９～３６のいずれかの方法であって、前記第２電位の値は、前記アドレス電極に対してアドレスされる最大電位と最小電位との両方において非偏向状態を形成する、前記アドレス電極に対してアドレスされる最大電位の半分に実質的に等しく、前記第３電位は、前記アドレス電極に対してアドレスされる前記最小電位に実質的に等しい方法。
【請求項３８】
請求項２９～３７のいずれかの方法であって、更に以下の工程：
前記可動マイクロ素子を、その中間部分に沿って、捻れ軸心を形成する一対の捻りヒンジによって支持する工程を包含する方法。
【請求項３９】
請求項２９～３７のいずれかの方法であって、更に以下の工程：
前記可動マイクロ素子を、その中間部分に沿って、傾動軸心を形成する一対の回動部材によって支持する工程であって、ここで、前記復帰部材は、非偏向状態において前記可動マイクロ素子を復帰させるとともに、これと同時に、前記可動マイクロ素子が前記傾動軸心回りで傾動することを許容することが可能な少なくとも１つの屈曲ヒンジである工程を包含する方法。
【請求項４０】
請求項３８～３９のいずれかの方法であって、更に、以下の工程：
少なくとも１つの屈曲ヒンジによって前記可動マイクロ素子を復帰させる工程を包含する方法。
【請求項４１】
請求項２９～３７のいずれかの方法であって、更に、以下の工程：
前記可動マイクロ素子を、その中間部分の１つに沿って、前記可動マイクロ素子を弛緩状態に復帰させるとともに、これと同時に、前記可動マイクロ素子が前記少なくとも１つの

電極を有する前記表面に対して垂直移動することを許容することが可能な一対の屈曲ヒンジによって支持する工程を包含する方法。
【請求項４２】
請求項２９～３７のいずれかの方法であって、更に、以下の工程：
前記可動マイクロ素子を、その中間部分の二つに沿って、前記可動マイクロ素子を弛緩状態に復帰させるとともに、これと同時に、前記可動マイクロ素子が、前記少なくとも１つの電極を有する前記表面に対して垂直移動することを許容することが可能な一対の屈曲ヒンジによって支持する工程を包含する方法。
【請求項４３】
請求項４１～４２のいずれかの方法であって、前記屈曲ヒンジは、多角形の角部に取り付けられている方法。
【請求項４４】
請求項４１～４２のいずれかの方法であって、前記屈曲ヒンジは、多角形の面部に取り付けられている方法。
【請求項４５】
請求項３８～４４のいずれかの方法であって、前記屈曲ヒンジの少なくとも１つおよび／又は前記捻れ軸心の少なくとも１つは、曲折形状である方法。
【請求項４６】
請求項２９～４５のいずれかの方法であって、前記可動マイクロ素子は、請求項１～２３のいずれかの可動マイクロ素子である方法。
【請求項４７】
請求項３５又は３６のいずれかの方法であって、更に、以下の工程：
前記所定パルス信号を、前記時間Δｔ’が、前記所定信号のパルス長と実質的に等しくなるように、前記時間Δｔ＋Δｔ’と同期させる工程を包含する方法。
【請求項４８】
請求項２９の方法であって、更に、以下の工程：
前記パルス信号が前記可動マイクロ素子に到達することを阻止しながら累積履歴作用を中和化する工程を包含する方法。
【請求項４９】
請求項４８の方法であって、前記中和化工程は、前記可動マイクロ素子が意図された作動中に偏向される状態に対してこれら個々の可動マイクロ素子を逆方向に偏向させることによって行われる方法。
【請求項５０】
請求項４９の方法であって、個々の可動マイクロ素子は、前記累積時間及び第２偏向方向に於ける偏向の度合いに応じて、所与の時間及び所与の変更度、第１方向に偏向される方法。
【請求項５１】
請求項４８の方法であって、前記累積履歴作用の前記中和化は、加工物上の完全なパターンを構成する異なるストリップ間において行われる方法。
【請求項５２】
請求項４８の方法であって、前記累積履歴作用の前記中和化は、少なくとも１つの可動マイクロ素子が所定の累積時間偏向された後に行われる方法。

【国際調査報告】

1

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 02/00142

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: G02B 26/08, B81B 3/00
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: G02B, B81B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-INTERNAL

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5444566 A (GALE, R.O. ET AL), 22 August 1995 (22.08.95), figures 1C,3,11-15, abstract	1-3,7-9, 23-31,35-37, 46,47,48-52
Y		4-6,10-22, 32-34,38-45
Y	US 5629794 A (MAGEL, G.A. ET AL), 13 May 1997 (13.05.97), figures 1A,1B,2,6	4-6,19-22, 32-34,10-18, 38-45
Y	US 5382961 A (GALE, JR., R.O.), 17 January 1995 (17.01.95), figure 5a	28

[x] Further documents are listed in the continuation of Box C.   [x] See patent family annex.

* Special categories of cited documents:	"T" later document, published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A" document defining the general state of the art which is not considered to be of particular relevance	
"E" earlier application or patent but published on or after the international filing date	"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"O" document referring to an oral disclosure, use, exhibition or other means	
"P" document published prior to the international filing date but later than the priority date claimed	"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
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Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. + 46 8 666 02 86	Authorized officer Sture Elnäs /OGU Telephone No. + 46 8 782 25 00

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2

INTERNATIONAL SEARCH REPORT

International application No.
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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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A	US 5912758 A (KNIPE, R.L. ET AL), 15 June 1999 (15.06.99), abstract, figures --	1-52
A	EP 0463348 A2 (TEXAS INSTRUMENTS INCORPORATED), 2 January 1992 (02.01.92), abstract -- -------	1-52

INTERNATIONAL SEARCH REPORT
Information on patent family members

					01/05/02	International application No. PCT/SE 02/00142

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BE,CH,CY,DE,DK,ES,FI,FR,GB,GR,IE,IT,LU,MC,NL,PT,SE,TR),OA(BF,BJ,CF,CG,CI,CM,GA,GN,GQ,GW,ML,MR,NE,SN,
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L,PT,RO,RU,SD,SE,SG,SI,SK,SL,TJ,TM,TN,TR,TT,TZ,UA,UG,US,UZ,VN,YU,ZA,ZM,ZW

(72)発明者　リュングブラッド，ウルリック
　　　　　　スウェーデン　エス‐４３１　３８　モルンダル　アルフホイズガタン　１２
(72)発明者　ランカー，フーベルト，カール
　　　　　　ドイツ連邦共和国　０１９００　グロスレールスドルフ　メランヒトンシュトラーセ　２２
(72)発明者　ドゥル，ペーター
　　　　　　ドイツ連邦共和国　０１０９９　ドレスデン　アラウンシュトラーセ　９６